Foreword

The Soil Survey of Klamath County, Oregon, Southern Part, is the product of many soil scientists, plant specialists, soil engineers, extension specialists, land owners, and others who worked and cooperated as a team to complete this project. In this report are many kinds of basic information about the soils in the area. This information can be helpful in making decisions about the management of irrigated soils for optimum crop production, in planning land uses for urban and suburban areas, and in determining the needs for many other uses, for example, forestry, range, wildlife, and recreation.

This soil survey has been prepared for many different users. Farmers can use it to help select the most suitable crop for the kind of soil; ranchers can use it to determine amount of forage production and the kinds of plants most suited to range or woodland; foresters can use the survey to find information about kinds of trees, potential for tree growth, and special soil features affecting logging, tree planting, and the ability of trees to resist windthrow.

This soil survey gives detailed information about engineering characteristics and properties of the soils for engineers and others who need this information. It gives interpretations for community uses and land use planning for planners, community decision makers, engineers, developers, builders, and home buyers. Finally, the survey can help others, for example, conservationists, recreationists, teachers, students, and specialists in wildlife management, waste disposal, or pollution control find ways to preserve, protect, and enhance the environment.

Because all soils are not alike, detailed information about the soils in the survey area is needed. Many soils have high water tables or have accumulated excessive amounts of sodium and salt. Some soils have hardpans, subsoils of clay, or a sandy substratum. The soils in the northern part of the survey area have contrasting properties, mainly because of the coarse textured pumiceous ash in which they formed. Other soils on drained lake bottoms formed in lacustrine sediment derived mainly from tiny plants called diatoms. Material from these soils have very low strength for foundations and roads and is highly unstable if used for dikes. These soil properties and many others that affect soil behavior and management are described in this soil survey.

At the back of this survey is the general soil map which shows the location of broad areas of soils, and detailed soil maps which show each kind of soil in the survey area. In addition, each kind of soil and how it can be used is described within the report. Additional information or assistance in using this publication can be obtained from the Soil Conservation Service or the extension agents of the Oregon Extension Service.

Guy W. Nutt
State Conservationist
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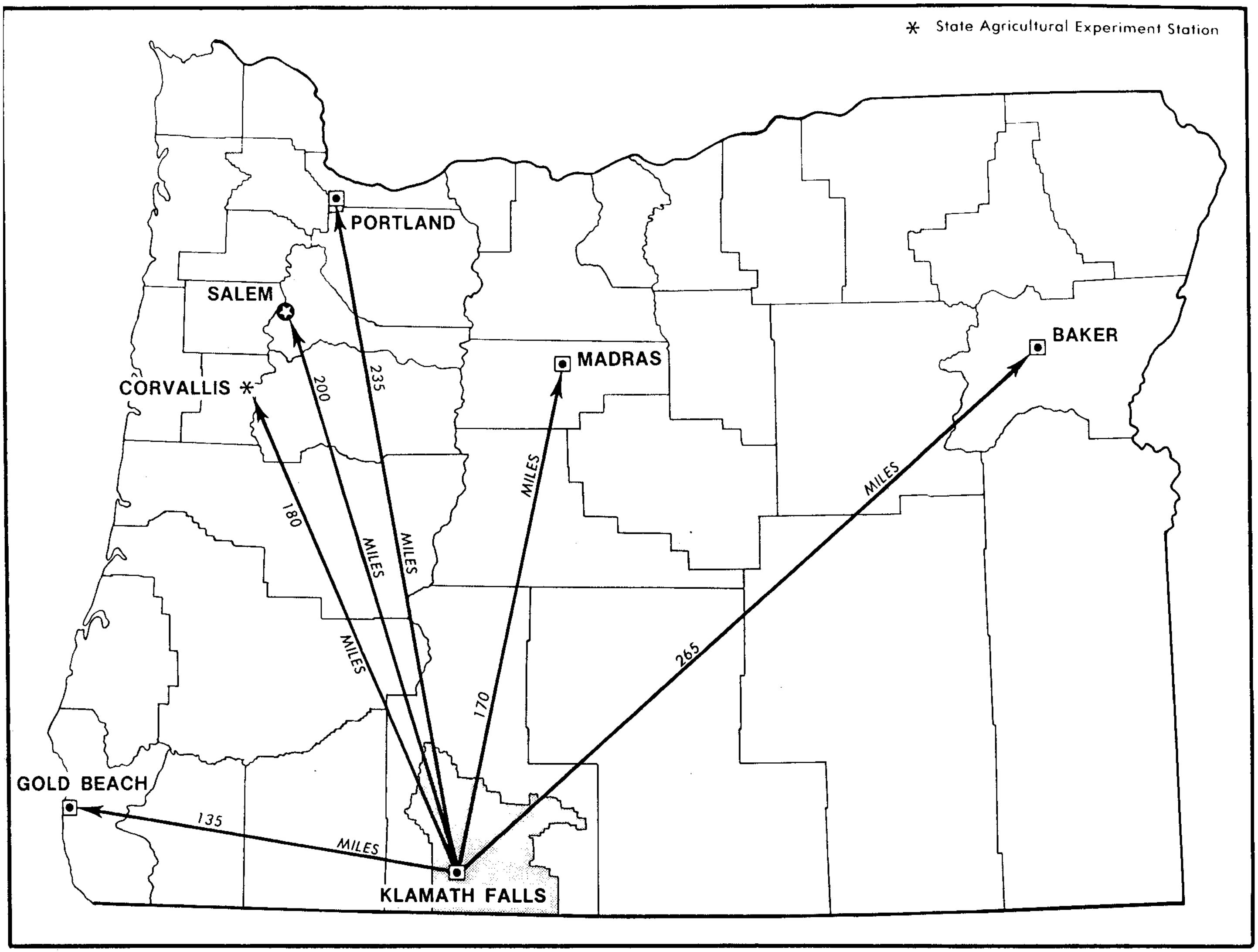

Location of Klamath County, Southern Part, in Oregon.

SOIL SURVEY OF KLAMATH COUNTY, OREGON

SOUTHERN PART

By Joe Cahoon, Soil Conservation Service

Fieldwork by John Tribe, Joe Cahoon, Lee DeMoulin, Don Taylor, Joseph Boda, Roger Borine, and Raymond Obrigewitsch
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United States Department of Agriculture, Soil Conservation Service, in cooperation with
Oregon Agricultural Experiment Station

Klamath County, Southern Part, includes most of southern Klamath County in south central Oregon (see facing page). Almost all of the cropland and urban and built-up areas are in this part of the county. The Oregon-California State Line forms the southern boundary, and the Cascade Mountains form the western and part of the northern boundaries. Lava hills and tablelands are to the north and east. Excluding water, the survey area is about 1,045,382 acres in size.

The survey area mainly consists of numerous basins of low elevation that are separated by very steep mountain ridges. Elevation ranges from about 4,050 feet on the basin floors to more than 7,000 feet on higher ridges. Annual precipitation ranges from about 10 to 35 inches within the area. Nearly all of the irrigated cropland and towns are in the basins. Mountainous parts of the area mostly are covered with timber or shrubs and grasses.

Timber products, cattle ranching, irrigation farming, and tourism are the main industries. The area is adjacent to Crater Lake National Park, numerous mountain lakes and streams, and wilderness areas.

Klamath Falls, which is the largest town in the survey area, is the center of county government. It is about midway between Portland, Oregon, and Sacramento, California. It is the largest rail and distribution center in southern Oregon and northern California. Chiloquin, Sprague River, Beatty, Bly, Dairy, Merrill, and Malin are other towns on rail lines. Bonanza and Lorella, in the southeastern part of the survey area, are serviced by all-weather paved roads. A large airfield that has daily flights to Portland, Sacramento, and San Francisco is a short distance from Klamath Falls.

GENERAL NATURE OF THE AREA

The principal landscape features in the area consist of basins enclosed on two or more sides by very steep mountain ridges. The basins and ridges trend toward the north and range from about 3 to 25 miles in length. Langell, Poe, Yonna, Swan Lake, Pine Flat, Lower Klamath, Sprague River, and Wood River Valleys are larger basins. Bryant Mountain, Stukel Mountain, Naylox Mountain, and Swan Lake Ridge are larger mountains.

The growing season varies considerably among the basins. The warmer basins in the southern part of the area, for example, Lower Klamath, Langell, Poe, Yonna, and Swan Lake Valleys, and Modoc Point have a growing season of about 90 to 120 days, and are suited to such irrigated crops as alfalfa hay, wheat, oats, barley, cereal hay, and pasture. Irish potatoes are produced in Klamath, Yonna, and Poe Valleys near the southern end of Swan Lake Valley, and Modoc Point. Dryland wheat, alfalfa hay, and pasture are grown in some parts of those basins at a higher elevation than the water supplies.

The Sprague and Wood River Valleys, in the northern part of the survey area, have shorter growing seasons, and are not suited to such crops as potatoes, wheat, and barley. The Sprague River Valley has a growing season of about 50 to 70 days. Alfalfa hay, rye or oat hay, and pasture mainly are grown. The Wood River Valley, which receives cold air drainage from the Cascades and Crater Lake, has a growing season of less than 50 days, the shortest growing season of all the basins. Only irrigated pasture is suitable.

Lower Klamath Lake in the southern part of the survey area is adjacent to the state of California. It was formerly a shallow lake of about 40 square miles and was drained in the early part of the century to be used for irrigated cropland. The soil is protected from flooding by dikes and is drained and irrigated by a system of interconnected canals and ditches. Pumping is needed to maintain the water table at desired levels.

Modoc Point is a fan-shaped delta of the Williamson River near Agency Lake. It is about 15 squire miles size and mainly is irrigated with water diverted from the Sprague and Williamson Rivers.

Mountainous areas are mostly used for timber, range, and wildlife habitat. Where annual precipitation is between 10 to 16 inches, they have a plant cover consisting mostly of big sagebrush, antelope bitterbrush, western juniper, other shrubs, and bunchgrasses: Where annual precipitation averages between 16 to 35 inches, they are covered with forests of ponderosa pine, Douglas-fir, sugar pine, white fir, and other trees.

Upper Klamath and Agency Lakes lie at the foot of the Cascades in the western part of the survey area. They cover about 62,000 acres. Average water depth of these lakes is about 12 feet. The northern part of the area is drained by the Williamson, Sprague, and Wood Rivers which flow into Agency Lake. That lake is connected to Upper Klamath Lake by a short, narrow waterway and the two lakes are drained by the Link and Klamath Rivers, a single river system which flows into California. Lost River, which rises in California, drains the southern part of the survey area, and flows back into California a short distance from its place of origin.

Climate

This section was prepared by Stanley G. Holbrook, 1972, climatologist for Oregon, U. S. Department of Commerce, National Weather Service.

Prevailing air masses move across Klamath County from the Pacific Ocean but are greatly modified when moving over the Coast Range and Cascade Mountains. Continental air masses that move down from the interior of western Canada are also a major weather factor. The resulting climate is much drier than that of western Oregon which has more extreme temperatures, particularly in winter months. Temperature and precipitation data for Chiloquin and Klamath Falls are shown in tables 1 and 2.

The winter rainfall in the area is characterized by a secondary peak in May just prior to the dry summers. Seasonal characteristics are well defined and changes between seasons are generally gradual. Average annual precipitation ranges from 10 to 15 inches in the valleys, 16 to 25 inches in nearby hills, and 30 to 40 inches at the lower levels in the Cascades to the west. About 44 percent of the moisture in the survey area occurs in winter, 22 percent in spring, 8 percent in summer, and 26 percent in fall. Wet days with at least .10 inch of moisture vary from 43 days annually in the valleys to 105 days in the mountains. The greatest daily precipitation has ranged from 2.44 to 3.73 inches in the southern part of the survey area and from 4.34 to 7.13 inches in the northern part and mountains.

Snowfall accounts for 30 percent of the moisture in the valleys and as much as 50 percent of the moisture in the mountains. Annual snowfall averages 15 to 45 inches in the valleys, 60 to 125 inches in the foothills and over 160 inches in some places at more than 4,500 feet elevation. Maximum snow depths have varied from 2 to 3 feet in the valleys and from 5 to 6 feet in the hills and mountains.

The average daily maximum temperatures for Klamath Falls and Chiloquin agree closely, but the average daily minimum temperatures at Chiloquin are about 6 degrees cooler in winter and 12 degrees cooler in summer. At the 6,500 foot level in the mountains, maximum temperatures average from 5 degrees cooler in winter to 14 degrees cooler in summer than at Klamath Falls and Chiloquin. Record temperatures in the area have ranged from -28 degrees at Chiloquin in 1937 to 105 degrees at Klamath Falls in 1911. Warm days of 90 degrees or above average 15 days per year in the valleys and 5 days per year in the mountains. A temperature below zero is expected at Klamath Falls in 1 year out of 2, and 100 degrees and above occur in only 1 year out of 5. Cool mornings with temperatures below freezing occur 15 to 210 days annually in the valleys and from 230 to 250 days in the hills and higher elevations. Tables 3 and 4 show the probability for occurrence of various freezing temperatures after indicated dates in spring and before listed dates in fall. Freezing temperatures may occur in each month of the summer except in milder lakeside locations. The average freeze-free season varies from 15 days in summer in the mountains to 126 days near the valley lakes.

At Klamath Falls prevailing winds are southerly for November through February; westerly from March through July; and northerly during August, September, and October. Monthly speeds average from 4.4 miles per hour in September to 7.3 miles per hour in March. Wind conditions are calm 17 to 33 percent of the time. Fastest observed windspeed is 73 miles per hour. Thunderstorms average about 12 per year with an occasional severe hailstorm; damage, however, is rarely severe or widespread. Average yearly cloudiness is about 50 percent at Klamath Falls; 130 days are clear, 90 partly cloudy, and 145 cloudy. Early morning values of relative humidity average 74 to 83 percent year-round, and the afternoon low values range from 26 to 33 percent in summer to 62 to 74 percent in winter. Lake evaporation is 36 to 42 inches annually, of which 80 percent occurs from May through October.

Water Resources

This information is based on unpublished records of the United States Department of the Interior Bureau of Reclamation and the Bureau of Indian Affairs, and analytical data by the Federal Water Pollution Control Administration.

The largest acreage of irrigated land in the survey area is the Klamath Reclamation Project. It includes 123,767 acres in Klamath, Poe, Yonna, and Langell Valleys, and drained embayments around Upper Klamath Lake. The water for irrigation mainly is diverted from Upper Klamath

Lake and the Lost River system, with supplemental flow from the Klamath River.

In the Sprague River Valley, water is diverted for irrigation from the Sprague River. The Wood River Valley in the northern part of the area is irrigated with water from the Wood River and from other streams that empty into the valley. In the Modoc Point area, water is diverted from the Sprague River at Chiloquin, and is also pumped from the Williamson River. Land is irrigated from wells in the Swan Lake, Yonna, and Sprague River Valleys. Many flowing artesian wells are in the Sprague River Valley.

Streamflows fluctuate widely in the survey area, from year to year and from season to season. The combined flow of the Williamson and Sprague Rivers below their confluence ranges from about 1,000,000 to 400,000 acre feet annually with a mean flow of about 659,900 acre feet (10). This system empties into Upper Klamath and Agency Lakes. The Wood River which has a mean flow of about 164,200 acre feet; and Sevenmile, Annie, and Sun Creeks, and other creeks from the Cascade Mountains also flow into these lakes.

Upper Klamath Lake is drained at the south end by Link River into Lake Ewauna, which flows into the Klamath River about 1 mile south of Klamath Falls. Irrigation flows are diverted from Upper Klamath Lake into the A canal a short distance above the Link River Dam. The Lost River Diversion Channel connects the Klamath River and Lost River at a point about 3 miles south of Klamath Falls. Water can flow in either direction depending on demand and irrigation requirement. Summer streamflows on the Klamath River range from about 200 to 1,100 cubic feet per second, depending largely on the amount of water diverted for irrigation. Mean annual streamflow of the Lost River through Malone Diversion Dam is about 33,960 acre feet, and at Harpold Reservoir it is about 174,830 acre feet.

The quality of water that is used for irrigation generally is high. It varies somewhat, however, among drainage systems, specific points along these systems, and season of year. The surface waters that flow into Upper Klamath Lake are of the calcium-sodium bicarbonate type, and are low in total dissolved solids, sulfates, boron, chloride, and sodium. The sodium adsorption ratio varies from about 0.2 to 1.5 for these waters, and total dissolved solids are less than 100 parts per million. The Klamath River at a point about 3 miles south of Klamath Falls, has a sodium adsorption ratio of about 0.6 to 1.1 and less than 200 parts per million of total dissolved solids. The Lost River, below Malone Dam in Langell Valley, has a sodium adsorption ratio of about 0.5 to 0.6 and less than 150 parts per million of total dissolved solids. The sodium adsorption ratio increases to about 1.4 to 1.7, and total dissolved solids increase to as much as 400 to 430 parts per million at the Lost River Diversion Dam in Klamath Valley (19).

The quality of ground water from wells varies considerably. A few wells that have tapped hot water springs have enough total dissolved solids, boron, chloride, sodium, and fluoride to make them unsuitable for some uses, for example, for irrigation of sensitive crops. Most of the wells in the survey area, however, have high quality water for irrigation.

History and development

Europeans came to Klamath County, Southern Part, in the early nineteenth century. About 1820 Peter Skene Ogden led a party of Hudson Bay Company trappers into the area to trap and explore. Two military expeditions organized by John C. Fremont explored the area in the 1840's. In 1846, coinciding with Fremont's second trip, the Applegate brothers and Levi Scott laid out a trail from Oregon to the East which passed through the Klamath and Goose Lake Basins. A military party, surveying a railroad route from the Sacramento Valley to the Columbia River, came through the area in 1855. It was headed by Lieutenants Williamson and Abbott with a military escort led by Lieutenant Philip Sheridan (9).

The first water rights for irrigation were claimed in 1870. These claims were filed by Lucien Applegate for irrigation in the Swan Lake Valley, and by Silas Kilgore for irrigation along Lost River (9).

Irrigation began in the Wood River Valley in 1883. When the Van Grimmer irrigation ditch was dug, some 4,000 acres were placed under irrigation near the town of Merrill in 1886. The Moore Ditch in the town of Linkville was enlarged in 1892 so that additional town lots could be irrigated. The town of Linkville was renamed Klamath Falls in 1893.

The passage of the Reclamation Act in 1902 was an important event in the development of Klamath County. In 1903 the Modoc Point irrigation system was established. In 1915 the Klamath Project, which later became the Klamath Irrigation District, was approved by the Klamath Water Users Association. At that time the State of Oregon authorized the United States to lower the water level in Upper Klamath Lake, lower and drain Lower Klamath Lake, and use the beds of these lakes for storage. The State also ceded to the United States any land uncovered in the lowering and draining of these lakes.

The Southern Pacific Railroad was built through the Klamath County Area in 1907. At that time structures were built by the United States Reclamation Service along the Klamath Straights to divert the flood waters of the Klamath River into the Tule Lake and Lower Klamath Lake areas.

In 1908 President Theodore Roosevelt issued Executive Order No. 924. This order established the Klamath Lake Reservation on Lower Klamath Lake, the first wildlife refuge for waterfowl in the nation. Today there are 5 wildlife refuges in the Klamath Basin.

The first sawmill in the area was built by the United States Army in 1863 to supply lumber to the Indians.

When the Klamath Indian Reservation was established by treaty on October 14, 1864, a sawmill also was constructed at Klamath Agency. In addition, the Army set up a sawmill on the west side of Fort Creek near Ft. Klamath in 1870. After 1918, the timber on the Reservation began to be sold in large amounts to private concerns. The Federal Government terminated its supervision over Klamath Indian affairs in 1960, and at that time most of the land on the Reservation became privately owned. The Sprague River Valley west of Beatty, the Wood River Valley east of Wood River, and all of the Winema Forest in the survey area formerly were part of the Klamath Indian Reservation.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, home-buyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

Areas dominated by moderately deep or very deep, moderately well drained to very poorly drained soils on bottom lands, low terraces, and flood plains

These soils have slopes of 0 to 2 percent. Most of the soils in these 6 map units are used for cropland, mainly irrigated or subirrigated pasture. Many of the soils are subject to flooding, and all of the soils have a high water table. Some soils are used for homesites and small buildings, or as refuge for migratory waterfowl.

1. Henley-Poe-Laki

Moderately deep or very deep, somewhat poorly drained and moderately well drained soils that formed in alluvial and lacustrine sediment

Areas of these soils are in Modoc Point and on low terraces along Lost and Klamath Rivers. Slopes are 0 to 2 percent. Elevation ranges from 4,050 to 4,200 feet. The average annual precipitation is 10 to 14 inches, and the frost-free season is 80 to 110 days.

This map unit makes up about 5.5 percent of the survey area. About 30 percent of the unit is Henley soils, about 20 percent Poe soils, about 15 percent Laki soils, and 35 percent is soils of minor extent. Of minor extent are the Teeters, Hosley, Malin, Modoc, and Fordney soils.

The Henley soils are strongly alkaline or very strongly alkaline, and are somewhat poorly drained. They have a water table at a depth of about 1 foot to 3.5 feet. Henley soils have a surface layer of loam, sandy loam, or loamy fine sand. The subsoil is loam or fine sandy loam. The Poe soils are moderately alkaline to very strongly alkaline, and are somewhat poorly drained. They have a water table at a depth of 2 to 4 feet. Poe soils have a surface layer of fine sandy loam or loamy fine sand. The underlying material is loamy sand. Henley and Poe soils have an indurated hardpan at a depth of 20 to 40 inches. The Laki soils are moderately alkaline to strongly alkaline and are moderately well drained. They have a water table at a depth of 3 to 5 feet. Laki soils have a surface layer of loam or fine sandy loam. The subsoil and underlying material are loam.

This map unit is used mostly for irrigated pasture and for such alkali tolerant crops as barley and alfalfa hay. Irish potatoes are grown in some reclaimed areas of Poe and Laki soils. Parts of this map unit are in suburban areas near Klamath Falls and in the towns of Merrill and Malin.

Wetness and excessive amounts of sodium and salt limit these soils for cultivated crops. Wind erosion is a hazard on Poe soils and on some Henley and Laki soils. Wetness, the hazard of flooding on some unprotected areas, an indurated hardpan, and low strength of the soil are the main limitations for homesites, small buildings, and roads.

The soils in this map unit have fair potential for cultivated crops if they are drained and are partially reclaimed from alkali. They have good potential for community uses and fair potential as habitat for ring-necked pheasant, quail, and mourning doves in partially reclaimed areas if grain or cereal hay are grown and if cover is provided. Ducks and geese sometimes use these soils in spring and fall, particularly those areas of soils that are close to water.

2. Malin-Scherrard-Pit

Moderately deep or very deep, somewhat poorly drained and poorly drained soils that formed in alluvial and lacustrine sediment

Areas of these soils are on flood plains and low terraces along Lost River and on lake bottoms in Swan Lake, Long Lake, and Round Lake Valleys. Slopes are 0 to 1 percent. Elevation ranges from 4,050 to 4,200 feet. The average annual precipitation is 10 to 14 inches, and the frost-free season is 80 to 110 days.

This map unit makes up about 4 percent of the survey area. About 30 percent of the unit is Malin soils, about 10 percent Scherrard soils, about 10 percent Pit soils, and 50 percent is soils of minor extent. Of minor extent are the Bedner, Calder, Deter, Harriman, Henley, Lakeview, and Laki soils.

The Malin and Scherrard soils are strongly alkaline or very strongly alkaline and are somewhat poorly drained. The Malin soils have a surface layer of clay loam and a subsurface layer of silty clay. The underlying material is clay loam. Malin soils have a water table at a depth of 1.5 to 5 feet. The Scherrard soils have a surface layer of clay loam and a subsurface layer and subsoil of silty clay. Scherrard soils have a strongly cemented hardpan at a depth of 20 to 40 inches and a water table at a depth of 0 to 3.5 feet. The Pit soils are neutral to moderately alkaline and are poorly drained. They have a surface layer of silty clay and a subsurface layer of clay. The underlying material is silty clay. Pit soils have a water table at a depth of 0 to 4 feet; in Langell Valley the water table is at a depth of 2 to 4 feet.

This map unit is used mostly for irrigated pasture and cereal hay. Alta fescue and barley are the main cultivated crops on Malin and Scherrard soils, but alfalfa hay can be grown if the soils are drained and are partially reclaimed from alkali. Irrigated pasture is the main crop on Pit soils. This map unit has few homesites. The Pit soils are not used for buildings.

Wetness, excessive amounts of sodium and salt, and the low water intake rate limit these soils for cultivated crops. Wetness, the hazard of flooding on unprotected areas, low strength of the soils, and a high capacity of the subsoils to shrink and swell are limitations for homesites, small buildings, and roads.

The soils in this map unit have fair potential for cultivated crops if they are drained and if the Malin and Scharrard soils are partially reclaimed from alkali. They have poor potential for community uses and as habitat for ring-necked pheasant, quail, and mourning doves. Pit soils have good potential and Malin and Scherrard soils have fair potential for the development of shallow water areas for waterfowl. Ducks and geese use these soils in spring and fall, particularly those areas of soils that are close to water.

3. Tulana-Algoma-Teeters

Very deep, poorly drained soils that formed in diatomaceous sediment

Areas of these soils are on the drained bottom of Lower Klamath Lake, on the adjacent flood plain of the Klamath River, and on drained embayments along the southern and eastern sides of Upper Klamath Lake. Slopes are 0 to 1 percent. Elevation ranges from 4,080 to 4,150 feet. The average annual precipitation is 10 to 14 inches, and the frost-free season is 80 to 110 days.

This map unit makes up about 3.6 percent of the survey area. About 50 percent of the unit is Tulana soils, about 30 percent Algoma soils, about 15 percent Teeters soils, and 5 percent is soils of minor extent. Of minor extent are the Henley, Lather, Xerofluvents, and Zuman soils.

The Tulana soils are slightly acid to mildly alkaline in the upper part and slightly acid to very strongly acid in the lower part. They have a surface layer of silt loam. The underlying material is mucky silt, and very fine sandy loam. The Algoma and Teeters soils are strongly alkaline in the upper part. Algoma soils have a surface layer of silt loam. The underlying material is silt loam and fine sand. Teeters soils have a surface layer of silt loam. The underlying material is silt or silt loam. Tulana and Teeters soils have a water table at a depth of 2 to 5 feet, and Algoma soils have a water table at a depth of 1 foot to 2.5 feet. Teeters and Algoma soils are inundated for long periods unless protected by dikes.

The soils in this map unit mostly are used for irrigated pasture, barley, oats, and cereal hay. Irish potatoes, used mainly for seed, and some horseradish are grown on Tulana soils. Some alfalfa hay is grown on those Algoma soils that are drained and partially reclaimed from alkali. This map unit has no homesites or buildings.

Wetness and excessive amounts of sodium and salt limit these soils for cultivated crops. Wetness, the hazard of flooding, potential frost action, and low strength of the soils are the main limitations for homesites, small buildings, and roads.

The soils in this map unit have good potential for cultivated crops if they are adequately drained and if the Algoma and Teeters soils are partially reclaimed from alkali. They have poor potential for community uses and fair potential as habitat for ring-necked pheasant, quail, and mourning doves if grain or cereal hay is grown. They have good potential for the development of shallow water areas for migratory waterfowl. This map unit is in the path of one of the major flyways for migratory waterfowl in the Pacific Northwest, and the soils are used for resting and feeding by many ducks and geese in spring and fall.

4. Klamath-Ontko-Yonna

Very deep, poorly drained soils that formed in alluvium derived mainly from diatomite and in ash

Areas of these soils are on flood plains mainly along the Sprague and Williamson Rivers. Slopes are 0 to 2 percent. Elevation ranges from 4,140 to 4,400 feet. The average annual precipitation is 15 to 18 inches, and the frost-free season is 50 to 70 days.

This map unit makes up about 4.5 percent of the survey area. About 40 percent of the unit is Klamath soils, about 30 percent Ontko soils, about 15 percent Yonna soils, and 15 percent is soils of minor extent. Of minor extent are the Chiloquin, Dilman, Klamath Variant, and Sycan Variant soils.

Klamath and Ontko soils are neutral in the upper layers. The Klamath soils have a surface layer and subsoil of silty clay. The underlying material is silty clay and silty clay loam. Klamath soils have a water table at a depth of 0 to 3 feet. The Ontko soils have a surface layer of silty clay loam and a subsoil of clay loam. The underlying material is coarse sandy loam, loamy coarse sand and clay loam. Ontko soils have a water table at a depth of 0 to 4 feet. The Yonna soils are strongly alkaline or very strongly alkaline in the upper layers. They have a surface layer of loam and a subsoil of loam and sandy loam overlying a layer of buried clay loam and very fine sandy loam. Yonna soils have a water table at a depth of 2 to 5 feet.

The soils in this map unit mostly are used for irrigated pasture or native wet meadow pasture. Cereal hay is grown on a few partly drained soils.

Wetness, a short growing season, and alkali limit these soils for cultivated crops. These soils are subject to flooding unless protected by dikes. Wetness, the hazard of flooding, and potential frost action are the main limitations for homesites, small buildings, and roads. This map unit has no homesites or buildings.

The soils in this map unit have poor potential for cultivated crops and for community uses. They have good potential as habitat for migratory waterfowl and good potential for the development of shallow water areas for waterfowl. Many ducks, geese, and

5. Kirk-Chock

Very deep, poorly drained soils that formed in alluvium derived from cinders and ash

Areas of these soils are on the flood plains that make up most of the Wood River Valley. Slopes are 0 to 1 percent. Elevation ranges from 4,150 to 4,280 feet. The average annual precipitation is 16 to 24 inches, and the frost-free season is 10 to 50 days.

This map unit makes up about 2.7 percent of the survey area. About 70 percent of the unit is Kirk soils, about 20 percent Chock soils, and 10 percent mostly is a soil of minor extent. This minor soil is in narrow swales and potholes, and consists of black and very dark gray silt over very gravelly sand.

The Kirk soils have a surface layer of loam. The underlying material is very gravelly loamy sand from cinders and pumiceous ash. Kirk soils have a water table at a depth of 1 foot to 2 feet. The Chock soils consist of loam that mostly is ash. They have a water table at a depth of 1 foot to 2.5 feet.

The soils in this map unit mostly are used for irrigated or subirrigated pasture. Livestock that are brought from California in the spring mainly graze these soils. The animals are shipped back to California feedlots in the fall. The town of Fort Klamath is in this map unit.

Wetness and a short growing season limit these soils for cultivated crops. The soils are subject to flooding in spring unless protected by dikes. Wetness, the hazard of flooding, and potential for frost action are the main limitations for homesites, small buildings, and roads.

The soils of this map unit have poor potential for cultivated crops, because of the short growing season. They have good potential for the development of small, dredged water areas for waterfowl. This map unit is in the path of one of the major flyways for migratory waterfowl in the Pacific Northwest, and the soils are used extensively for resting and feeding by many ducks and geese

6. Lather-Histosols, ponded

Very deep, very poorly drained muck that formed in organic material

Areas of these organic soils are on diked and drained parts of Agency Lake Marsh, on drained embayments along the southern side of Upper Klamath Lake, and in adjacent areas of marsh. Slopes are 0 to 1 percent. Elevation is 4,130 to 4,145 feet. The average annual precipitation is 18 to 25 inches, and the frost-free season is 50 to 130 days.

This map unit makes up about 4 percent of the survey area. About 60 percent of the unit is Lather soils, about 35 percent Histosols, ponded, and 5 percent is soils of minor extent. Of minor extent are the Kirk, Chock, and Klamath soils.

The Lather soils are medium acid to neutral in the upper layers and strongly acid to slightly acid in the lower layers. They have a surface layer of muck. The upper part of the underlying material is diatomaceous silt and the lower part is mucky peat. Lather soils have a water table at a depth of 0 to 3 feet. Histosols, ponded, are areas of marsh that have a floor of organic material. About 30 percent of these areas consists of scattered clumps of aquatic plants and small hillocks. Depth of water among the clumps and hillocks is 0 to about 3 feet.

In this map unit the Lather soils mostly are used for irrigated pasture. Oats, cereal hay, and barley are grown on a small area south of the Williamson River. Histosols, ponded, mainly is a waterfowl refuge and is used by large numbers of migratory waterfowl.

Wetness, subsidence following drainage and cultivation, fire, and severe plant nutrient deficiencies limit the Lather soil for cultivated crops. Wetness, the continuing hazard of flooding or inundation that may result from dike failures, and low strength of the soil are the main limitations for homesites, small buildings, and roads.

The soils in this map unit have poor potential for cultivated crops and for community uses. They have good potential for the development of shallow water areas for waterfowl. This map unit is in the path of one of the major flyways for migratory waterfowl in the Pacific Northwest, and the soils are used by many ducks and geese for resting and feeding.

Areas dominated by shallow to very deep, excessively drained and well drained soils on benches, terraces, and low hills

These soils have a slope range from 0 to 35 percent. Most of the soils are irrigated cropland, but some soils are dryfarmed. Irish potatoes, alfalfa hay, small grains, and cereal hay are grown in map units 7 and 8, and dryland wheat, alfalfa, and pasture are grown in some small areas that are at a higher elevation than the water supplies. Because of the short growing season, cultivated crops are limited to alfalfa hay, pasture, and oat or rye hay in map

7. Fordney-Calimus

Very deep, excessively drained and well drained soils that formed in alluvial and lacustrine sediment

Areas of these soils are in Modoc Point and on terraces and terrace escarpments drained by the Lost and Klamath Rivers. Slopes are 0 to 35 percent. Elevation ranges from 4,050 to 4,700 feet. The average annual precipitation is 10 to 14 inches, and the frost-free season is 90 to 120 days.

This map unit makes up about 6.9 percent of the survey area. About 55 percent of the unit is Fordney soils, about 30 percent Calimus soils, and 15 percent is soils of minor extent. Of minor extent are the Capona, Henley, Laki, Poe, and Stukel soils.

The Fordney soils are excessively drained; however, they have a water table at a depth of about 3.5 to 5 feet in most areas where the slope is less than 2 percent. Fordney soils have a surface layer of loamy fine sand. The underlying material is loamy sand. The Calimus soils are well drained. They have a surface layer of loam or fine sandy loam. The subsoil and underlying material are loam.

The soils in this map unit mainly are used for irrigated crops. Irish potatoes, mainly are grown. Alfalfa hay, wheat, oats, barley, pasture, and cereal hay are also grown, and in some areas that are at a higher elevation than the water supplies dryland wheat, alfalfa, and pasture are grown. This map unit has many homesites; parts of the unit are in suburban and built-up areas.

Wind erosion and a high water intake rate limit the Fordney soils for cultivated crops. Where slope is too steep, erosion by irrigation runoff is a limitation on the Fordney and Calimus soils. Where slope is less than 2 percent, wetness can cause seepage in the basements of dwellings; most areas of these soils, however, have few limitations for homesites, small buildings, and roads.

The soils in this map unit have good potential for cultivated crops, and if slope is not excessive, they have good potential for community uses. They also have good potential as habitat for ring-necked pheasant, quail, and mourning doves if grain or cereal hay is grown and if cover is provided.

8. Modoc-Harriman-Dodes

Moderately deep to very deep, well drained soils that formed in lacustrine sediment or in residual material derived from tuff and diatomite

Areas of these soils are on terraces mainly in Klamath Valley. Slopes are 0 to 15 percent. Elevation ranges from 4,100 to 4,700 feet. The average annual precipitation is 10 to 14 inches, and the frost-free season is 90 to 120 days.

This map unit makes up about 2.2 percent of the survey area. About 40 percent of the unit is Modoc soils, about 20 percent Harriman soils, about 15 percent Dodes soils, and 25 percent is soils of minor extent. Of minor extent are the Calimus, Capona, Deter, Henley, Hosley, Laki, Malin, Poe, and Stukel soils.

The Modoc soils have an indurated hardpan at a depth of 20 to 40 inches. They have a surface layer of fine sandy loam and a subsoil of sandy clay loam and clay loam. The Harriman soils have soft bedrock at a depth of 40 to 60 inches. They have a surface layer of loam and a subsoil of clay loam and sandy clay loam. The Dodes soils have soft bedrock at a depth of 20 to 40 inches. They have a surface layer of loam and a subsoil of clay loam.

The soils in this map unit mainly are used for irrigated crops, for example, alfalfa hay, cereal hay, wheat, oats, barley, and pasture. Irish potatoes are grown on some soils where slopes are less than 5 percent. Areas that are at a higher elevation than the water supplies are used for dryland wheat, alfalfa hay, and pasture. This map unit has many homesites and includes a large suburban area west of Klamath Falls.

Limited soil depth on the Modoc and Dodes soils, and complex slopes and a hazard of erosion where slopes exceed about 2 percent limit these soils for cultivated crops. Low strength of the soils is the main limitation for homesites, small buildings, and roads.

The soils in this map unit have fair potential for cultivated crops and for community uses. They have good potential for the development of habitat for ring-necked pheasant, quail, and mourning doves if grain or cereal hay is grown and if adequate cover is provided.

9. Lobert-Bly

Very deep, well drained soils that formed in alluvial and lacustrine sediment containing ash

Areas of these soils are on terraces mostly in the Sprague River Valley and in the area east of Agency Lake. Slopes are 0 to 25 percent. Elevation ranges from 4,160 to 4,500 feet. The average annual precipitation is 15 to 18 inches, and the frost-free season is 50 to 70 days.

This map unit makes up about 1.5 percent of the survey area. About 45 percent of the unit is Lobert soils, about 25 percent Bly soils, and 30 percent is soils of minor extent. Of minor extent are the Crume, Klamath, Maset, Merlin, Ontko, Yainax, Yancy, and Yonna soils.

The Lobert soils have a surface layer of loam and a subsoil of loam and fine sandy loam. The underlying material is fine sandy loam and loamy fine sand. The Bly soils have a surface layer of loam and a subsoil of gravelly clay loam and clay loam.

This map unit has a close growing stand of ponderosa pine timber where the soils are not cultivated or burned over. The soils mostly are used for timber and grazing by livestock. Many areas have been cleared for cropland, and irrigated or dryland alfalfa hay, pasture, and cereal hay are grown. The growing season is too short for most other crops. Parts of this map unit, particularly the area near Agency Lake, are rapidly being developed for community uses.

The short growing season, availability of water for irrigation, and steep slopes on parts of some areas limit these soils for cultivated crops. Low strength of the soil is the main limitation for most areas for homesites, small buildings, and roads.

The soils in this map unit have fair potential for cultivated crops and for community uses if slopes are not excessive. They have good potential for production of ponderosa pine and woodland forage and browse, and good potential for development as habitat for mule deer. This map unit is used by many deer in spring,

10. Choptie-Yainax-Yancy

Shallow and moderately deep, well drained soils that formed in residual material derived from tuff, diatomite, and ash or in gravelly sediment

Areas of these soils are on rock benches, low hills, and terraces in the Sprague River Valley. Slopes are 0 to

30 percent. Elevation ranges from 4,200 to 4,700 feet. The average annual precipitation is 15 to 18 inches, and the frost-free season is 50 to 70 days.

This map unit makes up about 3.2 percent of the survey area. About 35 percent of the unit is Choptie soils, about 35 percent Yainax soils, about 15 percent Yancy soils, and 15 percent is soils of minor extent. Of minor extent are the Barkley, Fuego, Klamath, Maset, and Ponina soils.

The Choptie soils are underlain by bedrock at a depth of 12 to 20 inches. They have a surface layer and a subsoil of loam. The Yainax soils are underlain by bedrock at a depth of 20 to 40 inches. They have a surface layer of loam and a subsoil of clay loam. The Yancy soils have an indurated hardpan at a depth of 12 to 20 inches. They have a surface layer of clay loam and a subsoil of clay loam, gravelly clay, and very gravelly clay.

The soils in this map unit mostly are used for range and timber. Dryland and irrigated alfalfa hay, cereal hay, and pasture are also grown. The growing season is too short for most other cultivated crops. The towns of Beatty and Sprague River are in this map unit.

Limited rooting depth, low available water capacity, and the short growing season limit these soils for cultivated crops. Erosion is a hazard on slopes of more than 2 percent. Limited depth to bedrock or hardpan, low strength of the soils, and steepness of slope are the main limitations for homesites, small buildings, and roads.

The soils in this map unit have poor potential for cultivated crops and for community uses. The Yainax soils have good potential for production of ponderosa pine and forage and browse plants. The Choptie and Yancy soils have fair potential for the production of native forage plants, and as habitat for mule deer.

Areas dominated by shallow to very deep, well drained soils in mountainous areas

These soils and areas of Rock outcrop are on escarpments, tablelands, rock benches, and lava hills. Slopes range from 1 to 65 percent. Timber, range, and wildlife habitat are the main uses of these soils. Map units 11, 12, and 13 mostly are used for range and wildlife habitat because the soils, in nearly all places, have too many stones; too much Rock outcrop; or have slopes that are too steep to be cultivated. Map unit 14 produces much of the ponderosa pine timber grown in the survey area.

11. Lorella

Shallow soils that formed in residual material derived from tuff and basalt

Areas of these soils are in Modoc Point and on escarpments and rock benches drained by the Lost and Klamath Rivers. Slopes are 1 to 35 percent. Elevation ranges from 4,140 to 5,500 feet. The average annual precipitation is 10 to 16 inches, and the frost-free season is 90 to 120 days.

This map unit (fig. 1) makes up about 16.9 percent of the survey area. About 80 percent of the unit is Lorella soils, and 20 percent is soils of minor extent and Rock outcrop. Of minor extent are the Calimus, Dehlinger, Harriman, and Stukel soils.

The Lorella soils are underlain by bedrock at a depth of 10 to 20 inches. They have a surface layer of very stony loam and a subsoil of very cobbly clay loam and very cobbly clay.

The soils in this map unit mostly are used for range and wildlife habitat. In some places, the nonstony Lorella soils are used for irrigated crops, mainly pasture, and in some places they have been cleared and are seeded to wheatgrasses. Most of these areas are at a higher elevation than the water supplies. This map unit includes the town of Lorella and parts of Klamath Falls.

Shallow depth, low available water capacity, an excessive number of stones on the surface, and steep slopes limit these soils for cultivated crops. Shallow depth to bedrock, steepness of slope, low strength of the soil, and capacity of the subsoil to shrink and swell are the main limitations for homesites, small buildings, and roads.

The soils in this map unit have poor potential for cultivated crops and for community uses. They have fair potential for production of native forage plants. They have poor potential as habitat for mule deer and other rangeland wildlife.

12. Rock outcrop-Nuss

Rock outcrop, and shallow soils that formed in residual material derived from tuff

Areas of Rock outcrop and these soils are on escarpments and lava hills in the Sprague River Valley and in Antone Butte, Devils Garden, and Badlands and on escarpments in other places in the survey area. Slopes are 5 to 65 percent. Elevation ranges from 4,100 to 6,000 feet. The average annual precipitation is 12 to 18 inches, and the frost-free season is 20 to 120 days.

This map unit makes up about 3 percent of the survey area. About 60 percent of the unit is Rock outcrop, about 15 percent Nuss soils, about 15 percent Dehlinger soils, and 10 percent is soils of minor extent. Of minor extent are the Lorella and Maset soils.

The Nuss soils are underlain by bedrock at a depth of 12 to 20 inches. They have a surface layer of loam and a subsoil of clay loam. The Dehlinger soils are underlain by bedrock at a depth of more than 60 inches. They have a surface layer of very stony loam and a subsoil of extremely gravelly clay loam.

The soils in this map unit mainly are used for range and wildlife habitat. Dehlinger soils have a plant cover of shrubs and bunchgrasses and western juniper. Nuss soils have scattered ponderosa pine. This map unit has been subdivided for homesites on Antone Butte.

Excessive rock outcrop, surface stoniness, and steep slopes limit these soils for cultivated crops. Outcrops of rock, shallow depth to bedrock, and steepness of slope are the main limitations for homesites, small buildings, and roads.

The soils in this map unit have poor potential for cultivated crops and community uses. They have poor potential for the production of trees and native forage plants and poor potential as habitat for mule deer and other woodland and rangeland wildlife.

13. Woodcock-Nuss-Royst

Shallow to very deep soils that formed in colluvium and in material weathered from andesite, basalt, tuff, and ash

Areas of these soils are on escarpments and rock benches in the mountains south of the Sprague River Valley. Slopes are 1 to 60 percent. Elevation ranges from 4,200 to 6,500 feet. The average annual precipitation is 15 to 25 inches, and the frost-free season is 10 to 50 days.

This map unit makes up about 21.5 percent of the survey area. About 55 percent of the unit is Woodcock soils, about 15 percent Nuss soils, about 15 percent Royst soils, and 15 percent is soils of minor extent and Rock outcrop. Of minor extent are the Bly, Klamath, Oatman, and Ponina soils.

The Woodcock soils are underlain by bedrock at a depth of more than 60 inches. They have a surface layer of stony loam, a subsoil of extremely gravelly clay loam, and a substratum of extremely cobbly loam. The Nuss soils are underlain by bedrock at a depth of 12 to 20 inches. They have a surface layer of loam and a subsoil of clay loam. The Royst soils are underlain by bedrock at a depth of 20 to 40 inches. They have a surface layer of stony loam and a subsoil of very gravelly clay loam and very gravelly clay.

The soils in this map unit mostly are used for timber, grazing by livestock, and wildlife habitat. They are not cultivated for crops. Many dwellings are in this unit. A large area on Bly Mountain has been subdivided for homesites.

The short growing season, steep slopes, stoniness, and low available water capacity limit these soils for cultivated crops. Steepness of slope is the main limitation for homesites, small buildings, and roads on most of the Woodcock soils. Shallow depth to bedrock is a limitation on Nuss soils. Capacity of the subsoil to shrink and swell, slope steepness, and shallow depth to bedrock are limitations on Royst soils.

The soils in this map unit have poor potential for cultivated crops, and most of the soils have poor potential for community uses. They have good potential for the production of ponderosa pine and understory forage and browse plants and good potential as habitat for mule deer and other woodland wildlife.

14. Merlin-Yancy

Shallow soils that formed in material weathered from tuff and basalt

Areas of these shallow soils are on tablelands and lava benches near the Sprague River Valley and on Bly and Bryant Mountains. Slopes are 1 to 8 percent. Elevation ranges from 4,400 to 5,500 feet. The average annual precipitation is 15 to 18 inches, and the frost-free season is 20 to 50 days.

This map unit makes up about 3.8 percent of the survey area. About 45 percent of the unit is Merlin soils, about 25 percent Yancy soils, and 30 percent is soils of minor extent and Rock outcrop. Of minor extent are the Klamath, Maset, Ontko, Ponina, and Royst soils.

The Merlin soils are underlain by bedrock at a depth of 10 to 20 inches. They have a surface layer of extremely stony clay loam and a subsoil of clay loam and clay. The Yancy soils have an indurated hardpan at a depth of 12 to 20 inches. They have a surface layer of clay loam and a subsoil of clay loam, gravelly clay, and very gravelly clay.

The soils in this map unit mostly are used for range and wildlife habitat. They are not used for cultivated crops. All areas of the soil are at a higher elevation than the water supplies. The largest part of the map unit is on Knott Tableland, and much of this area has been subdivided for homesites.

Shallow soil depth, low available water capacity, an excessive number of stones, and the short growing season limit these soils for cultivated crops. Shallow depth to hard bedrock and an indurated hardpan, excessive stoniness, low strength of the soil, and capacity of the subsoil to shrink and swell are the main limitations for homesites, small buildings, and roads.

The soils in this map unit have poor potential for cultivated crops and for community uses. They have fair potential for the production of native forage and browse plants and fair potential as habitat for pronghorn antelope, mule deer, and other rangeland wildlife.

Areas dominated by moderately deep to very deep, well drained to excessively drained soils on tablelands, plains, and volcanic hills

These soils are mostly on lava plains, pumice flows,
terraces and escarpments north of the Sprague and Wood River Valleys. Slopes range to 55 percent. The
soils in these 2 map units mainly are used for timber and wildlife habitat. Ponderosa pine grown in this association have the highest yield and site index in the survey area.

15. **Shanahan-Lapine-Steiger**

Very deep or deep, somewhat excessively drained and excessively drained soils that formed in *ash and* in *cinders*

Areas of these soils are on terraces, lava plains, and escarpments north of Chiloquin and south of Crater Lake National Park. Slopes are 1 to 55 percent. Elevation ranges from 4,185 to 6,000 feet. The average annual precipitation is 18 to 35 inches, and the frost-free season is 10 to 50 days.

This map unit makes up about 5.3 percent of the survey area. About 35 percent of the unit is Shanahan soils, about 25 percent Lapine soils, about 20 percent Steiger soils, and 20 percent is soils of minor extent. Of minor extent are the Collier, Maklak, and Tutni soils.

The Shanahan soils are somewhat excessively drained. The surface layer is gravelly loamy coarse sand. The upper part of the underlying layer is coarse sand, and the lower part is a buried soil of fine sandy loam and extremely cobbly fine sandy loam. The Lapine soils are excessively drained. The surface layer is gravelly loamy coarse sand. The upper part of the underlying material is very gravelly coarse sand and the lower part is a buried soil of loam. The Steiger soils are somewhat excessively drained. The surface layer is loamy coarse sand and the substratum is gravelly coarse sand.

The soils in this map unit mainly are used for timber and wildlife habitat. Ponderosa pine or mixed stands of conifers that include ponderosa pine grow on these soils. Only a small amount of forage is produced, and grazing by livestock is limited. A few homesites, small parks, and camping areas are in this map unit.

The short growing season and a high water intake rate limit these soils for cultivated crops. Other than potential frost action, these soils have few limitations for homesites, small buildings, and roads. Seepage and contamination of ground water are potential hazards for such sanitary facilities as lagoons, landfills, and septic tank absorption fields.

The soils in this map unit have poor potential for cultivated crops and fair potential for community uses. They have good potential for ponderosa pine and poor potential for understory forage plants. They have good potential as habitat for mule deer, black bear, and other woodland wildlife.

16. Maset-Yawhee

Moderately deep or very deep, well drained or somewhat excessively drained soils that formed in ash over buried soils

Areas of these soils are northeast of Beatty and on terraces and escarpments between Swan Lake Point and the Sprague River. Slopes are 1 to 45 percent. Elevation ranges from 4,200 to 6,500 feet. The average annual precipitation is 17 to 25 inches, and the frost-free season is 10 to 50 days.

This map unit makes up about 11.4 percent of the survey area. About 55 percent of the unit is Maset soils, about 30 percent Yawhee soils, and 15 percent is soils of minor extent and Rock outcrop. Of minor extent are the Klamath, Merlin, Nuss, Ontko, Royst, and Woodcock soils.

The Maset soils are well drained and are underlain by bedrock at a depth of 20 to 40 inches. They have a surface layer of coarse sandy loam. The upper part of the underlying material is gravelly coarse sandy loam, and the lower part is a buried soil of gravelly sandy loam and very gravelly clay loam. The Yawhee soils are somewhat excessively drained and are underlain by bedrock at a depth of more than 60 inches. They have a surface layer of stony and very cobbly coarse sandy loam. The upper part of the underlying material is very cobbly loamy coarse sand, and the lower part is a buried soil of very gravelly fine sandy loam and very gravelly loam.

The soils in this map unit mainly are used for timber, grazing by livestock, and wildlife habitat. Irrigated alfalfa hay, pasture, and cereal hay are grown on a few areas of Maset soils that have gentle slopes. The Yawhee soils are not cultivated. Nearly all areas of these soils are at a higher elevation than the water supplies. The Maset soils have some homesites.

The short growing season and steep slopes limit these soils for cultivated crops. Steepness of slope and shallow depth to bedrock in the Maset soils are the main limitations for homesites, small buildings, and roads.

The soils in this map unit have poor potential for cultivated crops and fair potential for community uses where slopes are not too steep. They have good potential for ponderosa pine and understory forage and browse plants and good potential as habitat for mule deer and other woodland wildlife.

Broad land use considerations

Deciding which land should be used for urban or suburban development, industrial parks, and rural subdivisions is an important issue in the survey area. Each year, more land is developed for these uses and subtracted from the total acreage available for farm and ranchland, woodland, and rangeland. About 12,685 acres, or about 1 percent of the survey, is urban or built-up land. In addition, according to the Klamath County Planning Commission, about 35,000 acres has been subdivided for rural or recreational subdivisions. These subdivisions, with few exceptions, do not have developed water supplies for domestic use and sanitary facilities and are largely uninhabited. Generally, the soils in the survey area that have good potential for irrigation and for cultivated crops also have good potential for homesites, small buildings, roads, and other urban and suburban uses. The data in this report about specific soils in the survey area can be useful in planning future land use patterns.

In the past the professionally trained planner and the citizens involved often have not been consulted in land use planning, and the legal-political process often has been ignored. Some land owners near urban and built-up areas have been forced to subdivide good farmland because of an increase in the tax rate structure when those lands were appraised according to their value as subdivision land. Part of the decline in deer herds, public access to areas for recreation, and a significant loss of the timber and livestock grazing base in the survey area can be attributed to this transferral of land use.

Urban and suburban development of extensive areas of these soils is not feasible because of wetness, low strength of the soil, and the hazard of flooding. Such map units as Tulana-Algona-Teeters, Klamath-Ontko-Yonna, and Lather-Histosols, ponded, are not suited to urban development. In addition, shallow depth to bedrock makes cost of development very costly or prohibitively high in the Merlin-Yancy, Choptie-Yainax-Yancy, Rock outcrop-Nuss, and Lorella map units. In some areas, development is very costly because of wetness, low strength, and shallow depth to indurated hardpan; examples of such soils are the Malin-Scherrard-Pit and the Henley-Poe-Laki map units. Excessive slope can result in high development costs in the Lorella, Woodcock-Nuss-Royst, and Maset-Yawhee map units.

Areas of soils that are mostly favorable for urban and suburban development are in the Fordney-Calimus, Modoc-Harriman-Dodes, and the Lobert-Bly map units. Of these, the Fordney-Calimus and Modoc-Harriman-Dodes map units have the most highly productive soils for agricultural crops in the survey area. The Lobert-Bly map unit is mostly woodland, but these soils are favorable for irrigation. Large areas of the Shanahan-Lapine-Steiger map unit are suitable for development; however, this unit is mostly National Forest and is not available for development. The total acreage of soils that are available and that have characteristics favorable for development makes up about 15 percent of the survey area.

Most of the soils in the survey area that are not used for agricultural crops have good or fair potential for woodland, rangeland, and wildlife habitat. Only the Rock outcrop-Nuss complex is poorly suited to commercial timber, native forage plants, and use as wildlife habitat. The natural beauty of the Shanahan-Lapine-Steiger, Woodcock-Nuss-Royst, and Maset-Yawhee map units is enhanced by large areas of conifer forests which makes them suitable sites for parks and recreation areas if slopes are not excessive. The Tulana-Algoma-Teeters and Lather-Histosols, ponded, map units are in a major North American flyway for migratory waterfowl and are important in refuge management and preservation of many kinds of waterfowl and other wetland wildlife.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. Colors of soil layers in the description are for moist conditions. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have a profile that is almost alike make up a *soil series.* Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a soil phase commonly indicates a feature that affects use or management. For example, Calimus loam, 0 to 2 percent slopes, is one of several phases within the Calimus series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes and soil associations.

A soil complex consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Henley-Laki complex is an example.

A soil association is made up of soils that are geographically associated and are shown as one unit on the map because it is not practical to separate them. A soil association has considerable regularity in geographic pattern and in the kinds of soil that are a part of it. The extent of the soils can differ appreciably from one delineation to another; nevertheless, interpretations can be made for use and management of the soils. Klamath-Ontko-Dilman association is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas;* they are delineated on the soil map and given descriptive names. Rock outcrop is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 5, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Soil descriptions

1-Algoma silt loam. This poorly drained soil is on the flood plain of the Klamath River and on the drained bottom of Lower Klamath Lake. It formed in very deep lacustrine sediment of silty diatomaceous material underlain by fine sand. This soil has sufficient sodium to interfere with the growth of most crop plants. Slopes are 0 to 1 percent. Elevation is 4,085 to 4,150 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is black silt loam about 11 inches thick. The upper part of the underlying material is grayish brown and gray, mottled silt loam that extends to a depth of about 30 inches; the lower part is dark grayish brown and dark gray, mottled fine sand to a depth of 60 inches or more. The soil is strongly alkaline to a depth of 34 inches and moderately alkaline to a depth of 60 inches.

Included with this soil in mapping are small areas of Teeters soil and small areas of Tulana soil, each of which makes up about 10 percent of the map unit; and areas of soils that are mildly alkaline or moderately alkaline, which make up about 30 percent of the unit. Also included are a few spots of soil on Lower Klamath Lake which make up about 10 percent of the map unit. This soil has a muck surface layer.

Permeability is slow. Some roots penetrate to a depth of more than 60 inches. Runoff is very slow, and the soil would be ponded in places if not protected by dikes. Available water capacity is as low as 11 inches where the silty upper part of the soil is 20 inches thick and salinity is high; it is as high as 24 inches where the silty part of the soil is nearly 40 inches thick and salinity is low. Content of organic matter is high in the surface layer. The water table fluctuates mostly from a depth of 1 foot to 2.5 feet and is partly controlled by deep canals that drain and subirrigate the soil. The soil is subject to long periods of frequent flooding from March to May.

This soil is used mainly for irrigated pasture, barley, and alfalfa hay. Crop yields vary considerably, both within a single field and among areas, because of variation in the amount of alkali in the soil. Selecting crops that grow under conditions of alkali and salinity help to obtain satisfactory yields. Wheat, oats, and Irish potatoes grow in this soil if drainage is adequate, and content of alkali is reduced. Only alta fescue, tall wheatgrass, and inland saltgrass for pasture grow in the most alkali and saline areas.

This soil is suited to border and sprinkler irrigation. Leveling generally can be accomplished by thin cuts. The amount and rate of water applied needs to be carefully adjusted to avoid overirrigating and raising the water table. Drains can dispose of accumulated water and prevent crop damage from submergence. Deep drains are needed to lower the water table below the root zone of crops and to permit leaching of alkali. Because drainage outlets are lacking, pumps are needed for drainage. Dikes are needed in most areas to protect cropland from flooding. Many areas are subirrigated from the water table. Subirrigation, however, can increase the rate at which sodium and salt accumulate in the soil.

Where drainage is adequate, much alkali can be leached from the soil by irrigation. The alkali and dispersed spots that resist leaching may respond to sulfur or gypsum (17). A long term cropping system that uses the more alkali sensitive crops is well suited to this soil as soon as the soil is reclaimed by leaching. After sufficient reclamation, the cropping system can include tall wheatgrass or alta fescue pasture for many years followed by barley grown for hay, and by alfalfa hay. When the soil is free of alkali, other small grain and possibly Irish potatoes can be grown.

Because of wetness, the hazard of flooding, and low strength, this soil has important limitations for such community uses as homesites, small buildings, and roads. The hazard of flooding, wetness, and seepage are limitations for lagoons and landfills. Because this soil is subject to piping, has very low strength, and is hard to compact in embankments, the use of it for construction has caused dike failure along the Klamath River. Wetness, slow permeability, or flooding can cause septic tank absorption fields to function poorly or fail. This soil is not used for homesites.

This soil is in capability subclass IIIw.

2A-Barkley loam, 0 to 2 percent slopes. This well drained soil is on terraces. It formed in very deep sediment weathered mainly from basalt, felsite, and a small amount of ash. A weakly developed hardpan is at a depth of 20 to 35 inches. The surface is hummocky in many places where it has not been leveled for irrigation. Elevation is 4,200 to 4,400 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 16 inches thick. The subsoil extends to a depth of 28 inches. The upper part, to a depth of 21 inches, is dark brown loam. The lower part, to a depth of 28 inches, is dark brown sandy clay loam. The upper part of the substratum, to a depth of 35 inches, is a dark brown gravelly sandy loam weakly cemented hardpan. The lower part, below the hardpan, is dark brown gravelly sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are about 5 percent areas of Yonna soil that are mostly less than 1 acre in size and about 10 percent areas of Crume soil. Also included is an area where the soil above the hardpan is fine sandy loam.

Permeability is moderate above the hardpan. Rooting depth commonly is 20 to 35 inches, but some roots penetrate the hardpan. Runoff is slow, and the hazard of erosion is slight. Available water capacity is as low as 3 inches where depth to the hardpan is only 20 inches; it is as high as 7 inches where depth to the hardpan is about 35 inches.

This soil is used mainly for irrigated pasture and alfalfa hay. Alta fescue and Kentucky bluegrass are used for pasture. A few dryland areas are used for oat or rye hay. Alfalfa, intermediate wheatgrass, and crested wheatgrass can also be used for hay and pasture in dryland areas. The vegetation in areas not cultivated is mainly big sagebrush, green rabbitbrush, antelope bitterbrush, Idaho fescue, bottlebrush squirreltail, and annual forbs and grasses.

Sprinkler and graded border irrigation systems are suited to this soil. The cuts made in leveling commonly expose the relatively infertile subsoil and can expose the hardpan or create shallow spots. Careful application of water is necessary to prevent overirrigation and perching a water table on top of the hardpan. A tillage pan forms readily if annual hay crops are grown in succession. Varying the depth of tillage, using minimum tillage, and occasionally chiseling or deep plowing help to prevent the formation of such a pan. Deep ripping may break up the hardpan if it is dry and can be shattered. If the hardpan is moist, it does not shatter well.

Because of potential frost action, this soil is limited for such community uses as homesites, small buildings, and roads. Limited soil depth can cause septic tank absorption fields to function poorly or fail in a few years. Many rural homes have been built on this soil.

This soil is in capability subclass IVc.

2B-Barkley loam, 2 to 8 percent slopes. This well drained soil is on terraces. It formed in very deep sediment weathered mainly from basalt, felsite, and a small amount of ash. A weakly developed hardpan is at a depth of 20 to 35 inches. The surface mostly is undulating to uneven. The average slope is about 4 percent. Elevation is 4,200 to 4,400 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is about 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 16 inches thick. The subsoil extends to a depth of 28 inches. The upper part, to a depth of 21 inches, is dark brown loam. The lower part, to a depth of 28 inches, is dark brown sandy clay loam. The upper part of the substratum, to a depth of 35 inches, is a dark brown gravelly sandy loam weakly cemented hardpan. The lower part, below the hardpan, is dark brown gravelly sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are about 10 percent areas of Crume soil that are mostly less than 1 acre in size; about 5 percent areas of Choptie soil;, and about 10 percent areas of soils that have a gravelly, heavy clay loam and clay subsoil underlain by an indurated hardpan.

Permeability is moderate above the hardpan. Rooting depth commonly is 20 to 35 inches, but some roots penetrate the hardpan. Runoff is slow, and the hazard of erosion is slight in uncompacted areas. Runoff and the hazard of erosion are increased where there is a tillage pan. Available water capacity is as low as 3 inches where depth to the hardpan is only 20 inches; it is as high as 7 inches where depth to the hardpan is about 35 inches.

This soil is well suited to irrigated pasture and alfalfa hay. Alta fescue and Kentucky bluegrass are suitable for irrigated pasture. Oat or rye hay also can be grown in dryland areas. Alfalfa, intermediate wheatgrass, and crested wheatgrass are well suited to dryland hay and pasture. At present, most areas are not cultivated. Big sagebrush, green rabbitbrush, antelope bitterbrush, Idaho fescue, bottlebrush squirreltail, and annual forbs and grasses are the main vegetation in these areas.

This soil is suited to sprinkler and corrugation irrigation. The deep cuts required in leveling can expose the hardpan and create shallow and infertile spots. Irrigating across the slope with corrugations needs to be carefully controlled to avoid erosion. A tillage pan forms readily if annual hay crops are grown in succession. Varying the depth of tillage, using minimum tillage, and occasionally chiseling or deep plowing help prevent formation of such a pan. Deep ripping may break up the hardpan if it is dry and not too thick to be shattered; if the hardpan is moist, however, it does not shatter well.

Because of potential frost action, this soil is limited for such community uses as homesites, small buildings, and roads. Shallow soil depth can cause septic tank absorption fields to function poorly and fail in a few years. Only a few homes and small buildings have been constructed on this soil.

This soil is in capability subclass IVe.

3-Bedner clay loam. This moderately well drained soil is on low terraces. It formed in very deep alluvial and lacustrine sediment weathered from tuff, basalt, and a small amount of ash. A weakly developed hardpan is at a depth of 20 to 35 inches. The surface in some areas is hummocky or mounded. Slopes are 0 to 1 percent. Elevation is 4,085 to 4,200 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 48 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is black clay loam about 6 inches thick. The subsoil extends to a depth of 21 inches. The upper part, to a depth of 18 inches, is very dark brown clay. The lower part, to a depth of 21 inches, is dark brown clay loam. The upper part of the substratum, to a depth of 31 inches, is a weakly cemented, very firm and brittle hardpan. The lower part, below the hardpan, is dark brown sandy clay loam to a depth of 60 inches or more.

Included with this soil in mapping are about 5 percent areas of Scherrard soil that are mostly less than 1 acre in size, about 10 percent areas of Calder soil, and about 30 percent areas of a soil in Swan Lake Valley that does not have a hardpan.

Permeability is slow above the hardpan. Rooting depth commonly is 20 to 35 inches, but some roots penetrate the hardpan. Runoff is very slow, and many areas are subject to frequent flooding from spring runoff. Depth of flooding mostly is less than 1 foot. Available water capacity is as low as 3 inches where depth to the hardpan is 20 inches; it is as high as 8 inches where depth to the hardpan is 35 inches. Content of organic matter is high in the surface layer.

This soil is used for irrigated crops, range, and wildlife habitat. Alfalfa hay, barley, wheat, and pasture are grown. Oats and cereal hay also are suited. Irish potatoes are not grown because of the clayey texture of the soil. Dryland areas are suited to pasture.

This soil is suited to sprinkler and level or graded border irrigation. Sprinkler systems need to be carefully designed because of the low water intake rate. Leveling in most places generally can be accomplished by only shallow cuts or by the smoothing of hummocks with a land plane. Deeper cuts can expose the clayey subsoil or the hardpan. The rate of water applied needs to be carefully controlled to prevent perching a water table on top of the hardpan. Drains can dispose of accumulated water and prevent crop damage. Diversions are needed to prevent flooding. Deep ripping may break up the hardpan if it is dry and can be shattered; if the hardpan is moist, however, it does not shatter well. This soil needs to be cultivated within a narrow range of moisture content. Tillage is difficult when the soil is too dry or too wet.

The climax native plant community on this soil is dominated by Nevada bluegrass and other bluegrasses, for example, Leiberg and Canby. A variety of perennial forbs grows in small amounts. Silver sagebrush is prominent because it is tolerant of the periodic high water table and ponding during spring runoff.

If the range site deteriorates, forbs and such low value shrubs as silver sagebrush and rabbitbrush increase and desirable grasses decrease. If the site severely deteriorates, silver sagebrush commonly dominates the plant composition and much ground is left bare.

Seedbed preparation and dryland seeding to tall wheatgrass are needed if the range is in poor condition. Plants selected for dryland seeding should be tolerant of short periods of ponding and should be drought resistant.

Because of low strength, a hazard of flooding, and a tendency to shrink and swell, this soil has important limitations for such community uses as homesites, small buildings, and roads. Slow permeability, the hazard of flooding and shallow depth to hardpan can cause septic tank absorption fields to function poorly and fail in a few years. This soil is not used for homesites.

This soil is in capability subclass IIIw.

4A-Bly loam, 0 to 2 percent loam. This well drained soil is on terraces. It formed in mixed alluvial and lacustrine sediment and a small amount of ash. Elevation ranges from 4,200 to 4,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The upper part of the subsoil is dark brown, gravelly clay loam that extends to a depth of about 35 inches; the lower part is dark brown clay loam to a depth of 60 inches or more.

Included with this soil in mapping are about 10 percent areas of Lobert soil that are mostly less than 1 acre in size, and about 5 percent areas of soils where the subsoil is clay. Also included are a few small areas where the soil is sandy loam below a depth of 25 inches, and a few places where the subsoil is very gravelly.

Permeability is moderately slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is 8 to 12 inches. The water-supplying capacity for natural vegetation is 12 to 16 inches.

This soil is used mostly for timber and grazing by livestock. It is suitable for irrigated and dryland crops, but the choice of crops is limited because of the short growing season. Alfalfa hay, annual hay crops of oats or rye, and pasture mainly are grown. Alta fescue is suited to irrigated pasture. Only a small acreage is irrigated because most areas are at a higher elevation than the water supplies.

This soil is suited to sprinkler, graded border, furrow, and corrugation irrigation. Corrugations can be used on slopes of 1 to 2 percent. Deep cuts made in leveling commonly expose the infertile subsoil.

This soil is well suited to the production of ponderosa pine. Timber is easily harvested by tractor logging except in winter and spring when snow is deep or when the soil is wet. Seedlings of ponderosa pine have a high rate of survival if the site is properly prepared and locally grown planting stock is used. Thinning is needed for good stand development because regeneration produces dense stands of seedlings and small trees.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 20 to 40 percent canopy cover in a moderately stocked mixed-age stand. The understory is dominated by Idaho fescue. A variety of perennial forbs occur throughout the stand. The shrub layer is dominated by antelope bitterbrush.

If the understory deteriorates, forage bunchgrasses decrease. Bitterbrush increases for a time and then decreases. If the understory severely deteriorates, annual weeds and such low value shrubs as big sagebrush and rabbitbrush dominate the understory. Deterioration of the understory commonly results in dense clumps of pine reproduction.

Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, hard fescue, and alfalfa are suitable for dryland seeding. Mule deer commonly use these plant communities in summer and fall for food and cover.

Because of low strength, potential frost action, and a tendency to shrink and swell, this soil has important limitations for such community uses as homesites and small buildings. Low strength is a limitation for roads and embankments. Moderately slow permeability in the subsoil can cause septic tank absorption fields to function poorly or fail in a few years. Many homesites have been built on this soil.

This soil is in capability subclass IVc.

4B-Bly loam, 2 to 8 percent slopes. This well drained soil is on terraces. It formed in mixed alluvial and lacustrine sediment and a small amount of ash. Most areas of the soil are woodland. The average slope is about 5 percent, but in parts of a few areas slope is as much as 20 percent. Elevation ranges from 4,200 to 4,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The upper part of the subsoil is dark brown, gravelly clay loam that extends to a depth of about 35 inches; the lower part is dark brown clay loam to a depth of 60 inches or more.

Included with this soil in mapping are about 10 percent areas of Yainax soil, a few areas of soils that have bedrock predominantly at a depth of 40 to 60 inches, and about 2 percent areas of Rock outcrop and stony patches.

Permeability is moderately slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is slow, and the hazard of erosion is slight unless the soil is irrigated. Available water capacity is 8 to 12 inches. The water-supplying capacity for natural vegetation is 12 to 16 inches.

This soil is used mostly for timber, grazing by livestock, and wildlife habitat. Irrigated and dryland alfalfa hay, annual hay crops of oats or rye, and pasture crops are grown in some areas; however, only a few crops are grown because of the short growing season. Alta fescue is suited to irrigated pasture. Most areas of this soil are at a higher elevation than the water supplies.

This soil is suited to sprinkler, graded border, and corrugation irrigation. Borders can be used on slopes that range to 4 percent if the slope is smooth and even. Sprinkler systems are better suited than other systems because the deep cuts that are needed to level the soil to grade for borders can expose the infertile subsoil in many places.

Careful application of water reduces the loss of soluble plant nutrients by leaching and the loss of soil by erosion. Such close growing crops as pasture and alfalfa reduce soil loss on irrigated land and on dryland. Farming across the slope, using crop residue, and fall chiseling after harvest reduce runoff and soil loss where dryland crops are grown and increase the soil moisture available for cultivated crops. Drainages between steeper slopes need to be seeded to grass to prevent gullying.

This soil is well suited to the production of ponderosa pine. Timber can be harvested easily by tractor logging except in winter and spring when snow is deep or when the soil is wet. Seedlings of ponderosa pine planted on this soil have a high rate of survival if site preparation is adequate, and if locally grown planting stock is used. Thinning is needed for good stand development because natural regeneration produces dense stands of seedlings and small trees.

The climax native vegetation on this soil is a ponderosa pine woodland community. In a moderately stocked mixed-age stand canopy cover is 20 to 40 percent. The understory is dominated by Idaho fescue. A variety of perennial forbs occurs throughout the stand. The shrub layer is dominated by antelope bitterbrush.

As the understory deteriorates, forage bunchgrasses decrease. Bitterbrush increases for a time and then decreases. If the understory severely deteriorates, annual weeds and such low value shrubs as big sagebrush and rabbitbrush dominate the understory. Deterioration of the understory commonly results in dense clumps of pine reproduction.

Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, hard fescue, and alfalfa are suitable for dryland seeding. Mule deer commonly use these plant communities in summer and fall for food and cover.

Because of low strength, potential frost action, and a tendency to shrink and swell, this soil has important limitations for such community uses as homesites and small buildings. Low strength is a limitation for roads and embankments. Moderately slow permeability in the subsoil can cause septic tank absorption fields to function poorly or fail in a few years. In a few places, this soil is used for homesites.

This soil is in capability subclass IVe.

5-Calder silt loam. This moderately well drained soil is on low terraces. It formed in lacustrine sediment weathered from lava rock, diatomite, and a small amount of ash. A hardpan is at a depth of 12 to 20 inches. Slopes are 0 to 1 percent. Elevation is 4,100 to 4,200 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 48 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is dark grayish brown silt loam about 5 inches thick. The subsurface layer is dark grayish brown silty clay loam about 3 inches thick. The subsoil is dark brown clay that extends to a depth of 14 inches. The upper part of the substratum, to a depth of 24 inches, is a dark brown strongly cemented hardpan; the lower part is a weakly cemented hardpan to a depth of 60 inches or more.

Included with this soil in mapping are about 5 percent areas of soils that are underlain by a hardpan at a depth of 6 to 12 inches and about 5 percent areas of Bedner soil. In Swan Lake Valley, alkali spots that are mostly Scherrard soil make up about 5 percent of this map unit.

Permeability is very slow in the subsoil and hardpan. Rooting depth is 12 to 20 inches. Runoff is very slow, and many areas of this soil are subject to occasional flooding from spring runoff. Depth of flooding is mostly less than 1 foot. Available water capacity is 2 to 4 inches. The water-supplying capacity for natural vegetation is 8 to 10 inches.

This soil is used for irrigated crops, range, and wildlife habitat. Pasture, oats, barley, and cereal hay are the main crops. Pasture crops are also well suited to dryland.

This soil is suited to level or graded border irrigation. Sprinkler systems are not suited because of the low water intake rate. Leveling generally can be accomplished by thin cuts or by smoothing of hummocks with a land plane. If deeper cuts are made, the infertile subsoil and hardpan are exposed. Careful application of water is needed to prevent perching a water table on top of the hardpan. Drains at the ends of borders can dispose of accumulated water and prevent crop damage from submergence.

Diversions can be used to protect this soil from flooding. Deep ripping may partially break up the hardpan if it is dry, but generally the hardpan is too thick to break through. The surface layer tends to form a hard crust that hinders or prevents seedling emergence. Addition of organic material softens this crust and improves soil structure in the surface layer.

The climax native plant community on this soil is dominated by Idaho fescue. Such small bluegrasses as Canby and Sandberg are prominent in the stand. A variety of perennial forbs grow in small amounts. Low sagebrush is prominent, and a few plants of antelope bitterbrush may occur.

If the range site deteriorates, Idaho fescue decreases and small bluegrasses, forbs, and low sagebrush increase. If the site severely deteriorates, the desirable bunchgrass is nearly eliminated and the low sagebrush has little vigor. In this condition, much of the ground is left bare and the soils are subject to severe frost heaving in spring when they are wet.

If the range is in poor condition, seedbed preparation and seeding to intermediate wheatgrass are needed. Plants selected for dryland seeding need to have strong seedling vigor and be drought resistant.

Because of low strength, the hazard of flooding, and a tendency of the subsoil to shrink and swell, this soil has important limitations for such community uses as homesites, small buildings, and roads. Very slow permeability and shallow soil depth can cause septic tank absorption fields to function poorly or fail in a few years.

This soil is in capability subclass IVw.

6A-Calimus fine sandy loam, 0 to 2 percent slopes. This well drained soil is on terraces near the edge of warmer basins. It formed in alluvial and lacustrine sediment weathered from diatomite, tuff, and basalt. Most areas of this soil were leveled for irrigation, but some areas now make up part of the suburban area south of Klamath Falls. Elevation ranges from 4,100 to 4,700 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown fine sandy loam about 11 inches thick. The subsoil is very dark grayish brown and dark brown loam that extends to a depth of about 40 inches. The substratum is dark grayish brown and very dark grayish brown loamy fine sand to a depth of 60 inches or more.

Included with this soil in mapping are about 3 percent scattered spots of Laki soil that are strongly alkaline, about 5 percent small areas of soils that have bedrock and hardpan at a depth of 40 to 60 inches, and about 20 percent areas of soils that have a surface layer of loamy fine sand. Areas of this map unit north of Modoc Point have soils that dominantly are very fine sandy loam and fine sandy loam.

Permeability is moderate. Roots commonly penetrate to a depth of 60 inches or more. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 7.5 to 9 inches. The water-supplying capacity for dryland crops is about 10 inches. A water table is at a depth of 2.5 to 4 feet in excessively irrigated areas. A considerable amount of water is lost from unlined canals and ditches by seepage.

This soil is used for many irrigated crops, for example, Irish potatoes, alfalfa hay, barley, wheat, oats, pasture, and annual hay crops. Size and quality of potatoes grown are among the best in the survey area. Many areas of this soil are at a higher elevation than the water supplies and are used for dryland wheat, alfalfa, and pasture. Crested wheatgrass and intermediate wheatgrass are grown for dryland pasture.

This soil is suited to sprinkler, graded border, and furrow irrigation. Leveling can be accomplished by comparatively deep cuts without exposing the infertile substratum. Sprinklers afford the most accurate control of soil moisture for potatoes and other crops and help to prevent raising the water table. Deep drains may be needed to lower the water table where excessive water is applied.

A tillage pan forms readily in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent formation of such a pan. Slick spots and persistent spots of alkali need to be treated with sulfur or gypsum. Use of grain and other crop residue improve tilth and soil structure. A cropping system of 5 or 6 years of alfalfa hay, 2 years of potatoes, and 1 year of grain is well suited to irrigated soils. On dryland, wheat can be grown following summer fallow. A suitable cropping system consists of several years of alfalfa, summer fallow, and wheat.

This soil generally is well suited to such community uses as homesites, small buildings, and sanitary facilities. Low strength limits the use of this soil for roads. Low strength, possible seepage, and susceptibility of the soil to piping are limitations for dams and other embankments. This soil is used for many homesites in rural areas.

This soil is in capability subclass IIc.

6B-Calimus fine sandy loam, 2 to 5 percent slopes. This well drained soil is on terraces and alluvial fans near the edge of warmer basins. It formed in alluvial and lacustrine sediment weathered mainly from diatomite, tuff, and basalt. Most areas of this soil are irrigated, but some areas now make up part of the suburban area south of Klamath Falls. Elevation ranges from 4,100 to 4,700 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown fine sandy loam about 11 inches thick. The subsoil is very dark grayish brown and dark brown loam that extends to a depth of about 40 inches. The substratum is dark grayish brown and very dark grayish brown loamy fine sand.

Included with this soil in mapping are about 10 percent areas of Fordney soil that are mainly less than 2 acres in size, about 10 percent areas of Capona soil that are less than 1 acre in size, and a few areas of soils that have scattered stony or very stony patches about 1 acre to 3 acres in size. Areas of soils north of Modoc Point dominantly are very fine sandy loam.

Permeability is moderate. Roots commonly penetrate to a depth of 60 inches or more. Runoff is slow, and the hazard of erosion is slight. Available water capacity is 7.5 to 9 inches. The water-supplying capacity for dryland crops is about 10 inches. Considerable water is lost from unlined canals and ditches by seepage.

This soil is used for many irrigated crops, for example, Irish potatoes, alfalfa hay, barley, wheat, oats, and pasture and annual hay crops. Size and quality of potatoes grown are among the best in the survey area. Many areas of this soil are at a higher elevation than the water supplies, and these soils are used for dryland wheat, alfalfa, and pasture crops. Crested wheatgrass and intermediate wheatgrass are suitable for dryland pasture.

This soil is well suited to sprinkler irrigation. Leveled areas can be irrigated by graded borders on slopes of as much as 4 percent. Furrows can be used across the slope if the slope does not exceed 2 percent. Corrugations also can be used. The very deep cuts commonly needed in leveling can expose the infertile underlying layers. Thinner cuts can expose bedrock on the Capona soil. Sprinklers afford the most accurate control of soil moisture for potatoes and other cultivated crops. In using any irrigation method, the rate of application of water needs to be carefully adjusted to prevent erosion. Because some areas of this soil are at a higher elevation than the water supplies, pumping water upslope from canals and ditches is needed to irrigate.

A tillage pan forms readily in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent formation of such a pan. Use of grain and other crop residue improve tilth and soil structure. If the soil is irrigated, a suitable cropping system is 5 to 6 years of alfalfa hay, 1 or 2 years of potatoes, and 1 year of grain. For dryland, a suitable cropping system consists of several years of alfalfa, summer fallow, and wheat. Stubble mulching, farming across the slope, and fall chiseling after harvest decrease runoff and soil loss from erosion and increase moisture available for future crops.

This soil generally is well suited to such community uses as homesites, small buildings, and sanitary facilities. Low strength limits the use of this soil for roads. Low strength, possible seepage, and susceptibility of the soil to piping are limitations for dams and other embankments. This soil is used for many homesites in rural areas.

This soil is in capability subclass IIe.

6C-Calimus fine sandy loam, 5 to 15 percent slopes. This well drained soil is on terraces and alluvial fans near the edge of warmer basins. It formed in alluvial and lacustrine sediment weathered mainly from diatomite, tuff, and basalt. Most areas of this soil are irrigated, but some areas now make up part of the suburban area south of Klamath Falls. The average slope is about 8 percent. Elevation ranges from 4,100 to 4,700 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown fine sandy loam about 11 inches thick. The subsoil is very dark grayish brown and dark brown loam that extends to a depth of about 40 inches. The substratum is dark grayish brown and very dark grayish brown loamy fine sand to a depth of 60 inches or more.

Included with this soil in mapping are about 15 percent areas of Fordney soil that are mainly less than 2 acres in size, about 10 percent areas of Capona soil, and a few areas of soils that have scattered stony or very stony patches about 1 acre to 3 acres in size.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 7.5 to 9 inches. The water-supplying capacity for dryland crops is 10 inches.

This soil is better suited to sprinkler irrigation than to other irrigation methods. Excessively deep cuts commonly needed in leveling can expose bedrock or the infertile substratum in many places. Even thin cuts tend to expose bedrock on the Capona soil. Rate of application of water needs to be carefully adjusted to prevent soil loss by erosion. Because some areas of this soil are at a higher elevation than the water supplies, pumping water upslope from canals or ditches is needed to irrigate.

A tillage pan forms readily in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent formation of such a pan. Use of grain crop residue improves tilth and soil structure. If the soil is irrigated, a suitable cropping system is 5 or more years of alfalfa or pasture and 2 years of grain or annual hay crops. On dryland, a suitable cropping system is several years of alfalfa, summer fallow, and wheat. Permanent pasture or cropping systems that use close growing plants are preferred. Use of crop residue, farming across the slope, and fall chiseling after harvest decrease runoff and soil loss from erosion and increase moisture available for future crops.

The climax native plant community on this soil is dominated by such tall bunchgrasses as basin wildrye and bluebunch wheatgrass. A wide variety of perennial forbs occur throughout the stand. Desirable shrubs, for example, antelope bitterbrush, big sagebrush, and Klamath plum are common; bitterbrush is most prominent.

If the range site deteriorates, tall bunchgrasses decrease. Subsequently, big sagebrush, the least desirable of the native shrubs, strongly increases and dominates the stand. If the site severely deteriorates, the bunchgrasses are nearly eliminated and only weeds and annual grasses remain under the brush. In this condition, western juniper invades from adjacent areas of shallow, stony soil, and if there are no periodic fires, juniper may dominate the range site in places.

If the range is in poor condition, seedbed preparation and seeding are needed. Intermediate wheatgrass, crested wheatgrass, and alfalfa are suitable for dryland seeding. Plants selected for dryland seeding should be drought resistant and have deep penetrating root systems.

Slope is an important limitation for such community uses as homesites, small buildings, and roads. Low strength is a limitation for roads. Because of low strength, susceptibility of the soil to piping, and possible seepage, the use of this soil for dams and other embankments is limited. This soil is used for many homesites in rural areas.

This soil is in capability subclass IIIe.

7A-Calimus loam, 0 to 2 percent slopes. This well drained soil is on terraces near the edge of warmer basins. It formed in loamy sediment weathered mainly from diatomite, tuff, and basalt. Most areas of this soil were leveled for irrigation, but some areas now make up part of the suburban area south of Klamath Falls. Elevation ranges four 4,100 to 4,700 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown loam about 14 inches thick. The subsoil is very dark brown, very dark grayish brown, and dark brown loam that extends to a depth of about 48 inches. The substratum is dark brown loam to a depth of 60 inches or more.

Included with this soil in mapping are about 5 percent spots of Laki soils that are strongly alkaline and about 5 percent areas of soils that have a hardpan at a depth of 40 to 60 inches. The surface layer is fine sandy loam in about 30 percent of the map unit.

Permeability is moderate. Roots commonly penetrate to a depth of 60 inches or more. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 9 to 13 inches. The water-supplying capacity for dryland crops is about 10 inches. A water table is at a depth of 2.5 to 4 feet during the irrigation period in excessively irrigated areas.

This soil is used for many irrigated crops, for example, Irish potatoes, alfalfa hay, barley, wheat, oats, and pasture and annual hay crops. Although yield is higher, potatoes grown in this soil are smaller and more difficult to clean than potatoes grown in the sandy soils in the survey area. Some areas of this soil are at a higher elevation than the water supplies, and these soils are used for dryland wheat, alfalfa, and pasture crops. Crested wheatgrass and intermediate wheatgrass are suitable for dryland pasture.

This soil is suited to sprinkler, graded border, and furrow irrigation. Comparatively deep cuts can be made in leveling for furrows and borders without exposing the infertile substratum. Sprinklers afford the most accurate control of soil moisture for potatoes and other crops and help prevent raising the water table. Deep drains are needed to lower the water table if an excessive amount of water is used to irrigate.

A tillage pan forms readily in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent formation of such a pan. Slick spots and persistent spots of alkali can be treated with sulfur or gypsum. Use of grain and other crop residue helps improve tilth and soil structure. A cropping system of 5 or 6 years of alfalfa hay, 2 years of potatoes, and 1 year of grain is well suited to this soil if it is irrigated. Wheat can be grown following summer fallow on dryland. A suitable cropping system for dryland is several years of alfalfa, summer fallow, and wheat.

This soil generally is well suited to such community uses as homesites, small buildings, and sanitary facilities. Low strength limits the use of this soil for roads. Low strength, possible seepage, and susceptibility of the soil to piping are limitations for dams and other embankments. This soil is used for many homesites and small buildings.

This soil is in capability subclass IIc.

7B-Calimus loam, 2 to 5 percent slopes. This well drained soil is on terraces and alluvial fans near the edge of warmer basins. It formed in alluvial and lacustrine sediment weathered mainly from diatomite, tuff, and basalt. Nearly all areas of this soil were leveled for irrigation, but some areas now make up part of the suburban area south of Klamath Falls. Elevation ranges from 4,100 to 4,700 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown loam about 14 inches thick. The subsoil is very dark brown, very dark grayish brown, and dark brown loam that extends to a depth of about 48 inches. The substratum is dark brown loam to a depth of 60 inches or more.

Included with this soil in mapping are areas of 5 percent Harriman and 5 percent Capona soils that are mostly less than 1 acre in size and about 20 percent areas of Harriman soil. Also included are a few areas of soils that have scattered stony or very stony patches 1 acre to 3 acres in size.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is 9 to 13 inches. The water-supplying capacity for dryland crops is 10 inches.

This soil is used for many irrigated crops. It is well suited to Irish potatoes, alfalfa hay, barley, wheat, oats, and pasture and annual hay crops. Although yield is higher, potatoes grown in this soil are smaller and more difficult to clean than potatoes grown in the sandy soils in the survey area. Many areas of this soil are at a higher elevation than the water supplies and are used for dryland wheat, alfalfa, and pasture crops. Crested wheatgrass and intermediate wheatgrass are suitable for dryland pasture.

This soil is well suited to sprinkler irrigation. Leveled areas can be irrigated by graded borders on slopes that range to 4 percent. Furrows can be used across the slope if the slope does not exceed 2 percent. Corrugations also can be used to irrigate. Leveling generally requires deep cuts that can expose the infertile underlying layers. Thin cuts tend to expose bedrock on the Capona soils. Sprinkler irrigation affords the most accurate control of soil moisture for potatoes and other cultivated crops. In using any irrigation method, the application of water needs to be carefully adjusted to prevent erosion. Because some areas of this soil are at a higher elevation than the water supplies, pumping water upslope from canals or ditches is needed to irrigate.

A tillage pan forms readily in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent formation of such a pan. Use of grain and other crop residue improves soil tilth and structure. If the soil is irrigated, a suitable cropping system is 5 to 6 years of alfalfa hay, 1 or 2 years of potatoes, and 1 year of grain. A suitable cropping system for dryland consists of several years of alfalfa, summer fallow, and wheat. Using crop residue, farming across the slope, and fall chiseling after harvest decrease runoff and soil loss from erosion and increase moisture available for future crops.

This soil generally is well suited to such community uses as homesites, small buildings, and sanitary facilities. Low strength is a limitation for roads. Because of low strength, possible seepage, and susceptibility of the soil to piping, the use of this soil for dams and other embankments is limited. The soil is used for many homesites.

This soil is in capability subclass IIe.

7C-Calimus loam, 5 to 15 percent slopes. This well drained soil is on terraces and alluvial fans near the edge of warmer basins. It formed in alluvial and lacustrine sediment weathered from diatomite, tuff, and basalt. Most areas of the soil are irrigated, but some areas now make up part of the suburban area south of Klamath Falls. The average slope is about 8 percent. Elevation ranges from 4,100 to 4,700 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown loam about 14 inches thick. The subsoil is very dark brown, very dark grayish brown, and dark brown loam that extends to a depth of about 48 inches. The substratum is dark brown loam to a depth of 60 inches or more.

Included with this soil in mapping are about 15 percent areas of Capona soil, about 5 percent areas of Stukel soil, and a few areas of soils that have scattered stony or very stony patches as much as 3 acres in size.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 9 to 13 inches. The water-supplying capacity for dryland crops is 10 inches.

This soil is used mainly for irrigated crops, for example, alfalfa hay, barley, wheat, oats, and pasture and annual hay crops. It is too steep to be used for potatoes. Many areas that are at a higher elevation than the water supplies are used for dryland crops. Wheat, alfalfa, and pasture are suited to dryland. A few areas are rangeland.

This soil is better suited to sprinkler irrigation than to other irrigation methods. The excessively deep cuts commonly needed in leveling can expose bedrock or the infertile substratum. Even thin cuts can expose bedrock on the Capona and Stukel soils. Rate of application of water needs to be carefully adjusted to prevent soil loss by erosion. Because some areas of this soil are at a higher elevation than the water supplies, pumping water upslope from canals or ditches is needed to irrigate.

A tillage pan forms readily in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent formation of such a pan. Use of grain crop residue improves tilth and soil structure. If this soil is irrigated, a suitable cropping system is 5 or more years of alfalfa hay or pasture and 2 years of grain or annual hay crops. A suitable cropping system for dryland is several years of alfalfa, summer fallow, and wheat. Permanent pasture or cropping systems that use close growing plants are suited to this soil. Using crop residue, farming across the slope, and fall chiseling after harvest can decrease runoff and soil loss from erosion and increase moisture available for future crops.

The climax native plant community on this soil is dominated by such tall bunchgrasses as basin wildrye and bluebunch wheatgrass. A wide variety of perennial forbs occurs throughout the stand. Desirable shrubs, for example, antelope bitterbrush, big sagebrush, and Klamath plum are common; bitterbrush is most prominent.

If the range site deteriorates, tall bunchgrasses decrease. Big sagebrush, the least desirable of the native shrubs, increases and strongly dominates the stand. If the site severely deteriorates, the bunchgrasses are nearly eliminated and only weeds and annual grasses grow under the brush. In this condition, western juniper invades from adjacent areas of shallow stony soil and, if there are no periodic fires, juniper dominates the range site in places.

If the range is in poor condition, seedbed preparation and seeding are needed. Intermediate wheatgrass, crested wheatgrass, and alfalfa are suitable for dryland seeding. Plants for dryland seeding need to be drought resistant and to have deep, penetrating root systems.

Slope is an important limitation for such community uses as homesites, small buildings, and roads. Low strength also limits the use of this soil for roads. Because of low strength, susceptibility of the soil to piping, and possible seepage, the use of this soil for dams and other embankments is limited. The soil is used for many homesites.

This soil is in capability subclass IIIe.

8D-Calimus-Capona loams, 15 to 35 percent slopes. These well drained soils are on north-facing escarpments near the edge of warmer basins. They formed in alluvial and lacustrine sediment weathered mainly from diatomite, tuff, and basalt. The average slope is about 20 percent. Elevation ranges from 4,100 to 4,700 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

This complex is about 55 percent Calimus loam, 15 to 35 percent slopes and about 35 percent Capona loam, 15 to 25 percent slopes. The rest of the complex consists of Stukel and Lorella soils and small areas of Rock outcrop.

Typically, the Calimus soil has a surface layer of very dark brown loam about 14 inches thick. The subsoil is very dark brown heavy loam that extends to a depth of about 40 inches. The substratum is dark brown loam to a depth of 60 inches. Bedrock is at a depth of more than 60 inches.

Permeability is moderate in the Calimus soil. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 9 to 13 inches. The water-supplying capacity is 10 inches for dryland crops and 10 to 12 inches for natural vegetation.

Typically, the Capona soil has a surface layer of very dark brown loam about 6 inches thick. The subsoil is very dark brown and dark brown light clay loam to a depth of about 21 inches. Tuffaceous bedrock is at a depth of 21 inches.

Permeability is moderate in the Capona soil. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 3 to 9 inches. The water-supplying capacity is 6 inches for dryland crops and 8 to 11 inches for natural vegetation.

This complex mainly is used for range and wildlife habitat. Most areas are at a higher water supplies, but a few areas are irrigated by pumping water upslope from canals or ditches. Dryland crops, mainly pasture, grow in some areas. If these soils are not in natural vegetation, they need to be seeded to permanent grass cover because of the hazard of erosion.

The climax native plant community on these soils is dominated by Idaho fescue. Bluebunch wheatgrass is prominent. Many perennial (orbs grow throughout the stand. A variety of desirable shrubs commonly occurs; antelope bitterbrush is the most prominent.

If the range site deteriorates, bluebunch wheatgrass and Idaho fescue decrease, and big sagebrush strongly increases and dominates the stand. If the site severely deteriorates, the bunchgrasses are nearly eliminated and only low value shrubs, weeds, and annual grasses remain. Western juniper invades from adjacent ridgetops, and if there are no periodic fires, juniper reproduction dominates the complex in places.

If the range is in poor condition, seedbed preparation and seeding are needed. Intermediate wheatgrass, crested wheatgrass, and alfalfa are suitable for dryland seeding. Plants selected for dryland seeding need to have deep penetrating root systems and to be drought resistant. Wildlife values of the total plant community, especially for deer, should be considered in planning management alternatives.

Because of the slope, these soils have important limitations for such community uses as homesites, small buildings, roads, and sanitary facilities. Low strength limits the use of the soil material for roads. Because of low strength, susceptibility to piping, and possible seepage, the use of this soil material for dams and other embankments is limited. The soils in this complex are used for only a few homesites.

These soils are in capability subclass IVe.

9A-Capona loam, 0 to 2 percent slopes. This well drained soil is on terraces. It formed in material weathered mainly from lacustrine tuff, diatomite, and basalt. Bedrock is at a depth of 20 to 35 inches. Most areas of the soil were leveled for irrigation, but some areas now make up part of the suburban area south of Klamath Falls. Elevation ranges from 4,100 to 4,700 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The subsoil is dark brown, gravelly sandy clay loam to a depth of about 25 inches. Tuffaceous bedrock is at a depth of 25 inches.

Included with this soil in mapping are about 5 percent areas of soils that are strongly alkaline, about 25 percent areas of soils that have a surface layer of fine sandy loam, and a few small areas of soils that have a hardpan instead of bedrock. Also included are as much as 20 percent areas of Stukel soil.

Permeability is moderate. Roots commonly penetrate to a depth of 20 to 35 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is as low as 3 inches where depth to bedrock is 20 inches and the subsoil is gravelly; it is as high as 7.5 inches where depth to bedrock is 35 inches and pebbles mostly are lacking. A temporary water table is perched above the bedrock following irrigation, and it is several inches above bedrock throughout the irrigation period in excessively irrigated areas.

This soil is used for many irrigated crops, for example, Irish potatoes, barley, oats, alfalfa hay, pasture, and annual hay crops. Although yield is higher, potatoes grown in this soil are generally smaller and more difficult to clean than potatoes grown in the sandy soils in the survey area.

This soil is suited to sprinkler, graded border, and furrow irrigation. Cuts of more than 1.5 feet made in leveling to grade for borders and furrows can expose bedrock in many places. Sprinkler irrigation affords accurate control of soil moisture for potatoes and other crops. Overirrigation by any method can rapidly raise the water table above bedrock and result in crop damage from waterlogging. Deep drains are needed to lower the water table where excessive water is used to irrigate. Tail water from borders and furrows can be disposed of in drains to prevent crop damage from submergence.

A tillage pan forms readily in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent formation of such a pan. Slick spots and persistent spots of alkali can be treated with sulfur or gypsum. Use of grain and other crop residue improve tilth and soil structure. A cropping system of 5 or 6 years alfalfa hay, 2 years of potatoes, and 1 year of grain is well suited to this soil.

Because of the moderate depth to bedrock, this soil has important limitations for such community uses as homesites, small buildings, roads, and excavations. Moderate soil depth can cause septic tank absorption fields to function poorly or fail. Seepage may occur where lagoons and reservoirs are placed on this soil. This soil is not a good source of material for topsoil and roadfill because of limited material available and the difficulty of restoring cut areas to vegetation. Many homesites are on this soil.

This soil is in capability subclass IIIs.

9B-Capona loam, 2 to 5 percent slopes. This well drained soil is on terraces and rock benches near the edge of warmer basins. It formed in material weathered mainly from tuff, diatomite, and basalt. Bedrock is at a depth of 20 to 40 inches. Slopes mainly are short and convex. Elevation ranges from 4,100 to 4,700 feet. The average annual temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The subsoil is dark brown, gravelly sandy clay loam to a depth of about 25 inches. Tuffaceous bedrock is at a depth of 25 inches.

Included with this soil in mapping are about 15 percent areas of Stukel and Calimus soils that are mainly less than 2 acres in size, and about 5 percent areas of very stony Lorella soil. Also included are many areas that have scattered stony or very stony patches 1 acre to 3 acres in size.

Permeability is moderate. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is as low as 3 inches where depth to bedrock is 20 inches and the soil is gravelly; it is as high as 8.5 inches where depth to bedrock is nearly 40 inches and where there are few pebbles. The water-supplying capacity is 9 to 12 inches for natural vegetation and 5 to 9 inches for dryland crops.

This soil is used mainly for irrigated and dryland crops. If carefully irrigated and managed, it is suited to Irish potatoes, barley, wheat, oats, alfalfa hay, and pasture and annual hay crops. Many areas are at a higher elevation than the water supplies. Some areas are seeded to crested wheatgrass. Dryland wheat also is suited to these areas following summer fallow.

This soil is well suited to sprinkler irrigation. Deep cuts needed in leveling for borders and furrows expose bedrock in many places. A few areas are irrigated by uncontrolled flooding. Because some areas of this soil are at a higher elevation than the water supplies, pumping water upslope from canals or ditches is needed to irrigate. Rate of application of water needs to be carefully adjusted to prevent erosion from runoff. Drainageways between some slopes can be seeded to grass to prevent the formation of gullies.

A tillage pan forms readily in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage, using minimum tillage, and occasionally deep plowing or chiseling can help prevent formation of such a pan. Permanent pasture or cropping systems that use close growing plants most of the time are well suited to this soil. If this soil is irrigated, a cropping system of 5 or 6 years of alfalfa hay and 2 years of grain is suitable where cross slope tillage and other practices are used to minimize erosion on grain crops. Farming across the slope, fall chiseling after harvest, and using crop residue if dryland grain is grown can reduce erosion from runoff and increase moisture for crop use.

Because of the moderate depth to bedrock, this soil has important limitations for such community uses as homesites, small buildings, roads, and excavations. Moderate soil depth can cause septic tank absorption fields to function poorly or fail. Seepage can occur where lagoons and reservoirs are placed on this soil. This soil is not a good source of material for topsoil and roadfill because of limited material available and the difficulty of restoring cut areas to vegetation. Many homesites are on this soil.

This soil is in capability subclass IIIe.

9C-Capona loam, 5 to 15 percent slopes. This well drained soil is on rock benches at the edge of warmer basins. It formed in material weathered from tuff, diatomite, and basalt. Bedrock is at a depth of 20 to 40 inches. Slopes are mainly short and complex. Elevation ranges from 4,100 to 4,700 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The subsoil is dark brown, gravelly sandy clay loam to a depth of 25 inches. Tuffaceous bedrock is at a depth of about 25 inches.

Included with this soil in mapping are about 10 percent areas of Stukel soil and 10 percent of Calimus soil that are mainly less than 2 acres in size, and about 10 percent areas of very stony Lorella soil. Also included are many areas that have scattered stony or very stony patches that are 1 acre to 3 acres in size.

Permeability is moderate. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is medium, and the hazard of erosion is high. Available water capacity is as low as 3 inches where depth to bedrock is 20 inches and the soil is gravelly; it is as high as 8.5 inches where depth to bedrock is 40 inches and pebbles mostly are lacking. The water-supplying capacity is 9 to 12 inches for natural vegetation and 5 to 9 inches for dryland crops.

This soil is used for irrigated crops, range, and wildlife habitat. If this soil is carefully irrigated and managed, alfalfa hay, barley, wheat, oats, pasture, and annual hay crops can be grown. The soil is too steep to be used for potatoes. Because of the high hazard of erosion, this soil is better suited to irrigated permanent pasture than to other crops. Many areas at a higher elevation than the water supplies are used for dryland crops or range. Wheat, alfalfa, and pasture crops are suitable.

This soil is well suited to sprinkler irrigation. Leveling for borders and furrows exposes bedrock in many places. A few areas are irrigated by uncontrolled flooding. Because some areas of this soil are at a higher elevation than the water supplies, pumping water upslope from canals or ditches is needed to irrigate. Rate of application of water needs to be carefully adjusted to prevent erosion from runoff. Drainageways between slopes can be seeded to grass to prevent the formation of gullies.

A tillage pan forms readily in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage, using minimum tillage, and occasionally deep plowing or chiseling can help prevent formation of such a pan. Permanent pasture or cropping systems that use close growing plants most of the time are suited to this soil. If this soil is irrigated, a cropping system of 5 or 6 years of alfalfa and 2 years of grain can reduce the hazard of erosion for grain crops. Farming across the slope, fall chiseling after harvest, and using crop residue if dryland grain is grown can reduce erosion from runoff and increase moisture for crop use.

The climax native vegetation on this soil is a plant community dominated by western juniper with about 10 to 15 percent canopy cover. Bluebunch wheatgrass is the dominant understory grass. Idaho fescue and Sandberg bluegrass are prominent. A variety of perennial forbs occurs throughout the stand. Antelope bitterbrush and lesser amounts of big sagebrush are the dominant shrubs.

If the range site deteriorates, bluebunch wheatgrass, Idaho fescue, and bitterbrush decrease and forbs, big sagebrush, and juniper increase. If the site severely deteriorates, the bunchgrasses and desirable shrubs, including big sagebrush, are nearly eliminated. In this condition, much ground is left bare under the junipers and the hazard of soil erosion is high. If deterioration is a result of recurring fire, juniper is nearly eliminated, and low value shrubs dominate the range site.

Seedbed preparation and seeding are needed if the range is in poor condition. Crested wheatgrass and ladak alfalfa are suitable for dryland seeding. Wildlife values, especially food and cover needs for deer winter range, should be considered in planning management alternatives.

Because of moderate depth to bedrock and slope, this soil has important limitations for such community uses as homesites, small buildings, roads, landfills, and excavations. Moderate soil depth can cause septic tank absorption fields to function poorly or fail. This soil is not a good source of material for topsoil and roadfill because of the limited material available and the difficulty of restoring cut areas to vegetation. Many homesites are on this soil.

This soil is in capability subclass IVe.

10-Chiloquin loam. This moderately well drained soil is on narrow flood plains. It formed in very deep alluvium weathered mainly from lava rocks, diatomite, and a small amount of pumiceous ash. Slopes are 0 to 1 percent. Elevation ranges from 4,175 to 4,300 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 42 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark brown and very dark grayish brown loam about 18 inches thick and about 15 percent pumiceous ash of coarse sand size. The subsoil is dark brown heavy loam that extends to a depth of about 28 inches. The substratum, to a depth of 60 inches or more, is dark brown and dark yellowish brown loam that is mottled below a depth of 43 inches.

Included with this soil in mapping are about 5 percent areas of Klamath soil and 5 percent of Yonna soil, and a few areas of soils that have a clay loam and a sandy loam surface layer. Also included are areas of soils along the west side of the Sycan River north of the village of Beatty that have coarse sandy loam ash in the upper 12 to 24 inches of the profile.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow. The hazard of erosion generally is slight; however, flooding can cause channeling. Available water capacity is 10 to 13 inches. A water table is at a depth of 1 foot to 3 feet in spring. The soil is subject to common flooding in spring.

This soil is used mainly for irrigated and dryland pasture and wildlife habitat. Alfalfa hay is grown in a few areas. Many areas that were cultivated at one time are now abandoned. If drained and protected from flooding, the soil is suitable for irrigated alfalfa hay and cereal hay crops. Silver .sagebrush, big sagebrush, green rabbitbrush, sedges, and annual grasses are the main natural vegetation in uncultivated areas.

This soil is suited to sprinkler and border irrigation. The surface commonly is uneven, and deep cuts may be needed in leveling for borders. Some areas near stream channels can protect the soil from flooding. Some streambanks need protection from cutting by streamflow. Because the water table mostly fluctuates with the level of water in the stream channel, drainage in some places is impractical. Leveling channeled or uneven areas can eliminate the wetter spots and permit more uniform irrigation. Strongly alkaline spots of Yonna soil may respond to gypsum or sulfur.

Because of wetness and the hazard of flooding, this soil has important limitations for such community uses as homesites, small buildings, and roads. Wetness and flood damage can cause septic tank absorption fields to function poorly or fail. Because of low strength and susceptibility to piping, the use of this soil material for dams and other embankments is limited. Few homesites or other structures are on this soil.

This soil is in capability subclass IVw.

11D-Choptie loam, 2 to 25 percent slopes. This well drained soil is on low hills. It formed in material weathered from pumice tuff, tuffaceous sandstone or tuffaceous breccia, and a small amount of ash. Bedrock is at a depth of 12 to 20 inches. Slopes are smooth and convex. The average slope is about 12 percent, but a few areas have slopes of as much as 45 percent. Elevation ranges from 4,325 to 4,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 6 inches thick. The subsoil is dark brown loam to a depth of about 16 inches. Hard tuffaceous bedrock that consists of angular fragments of white, black, and pink pumice is at a depth of about 16 inches.

Included with this soil in mapping are about 20 percent areas of soils that have soft bedrock and a subsoil of light clay loam, about 5 percent areas of smooth exposed bedrock near the tops of hills, and about 10 percent areas of Crume soil on lower parts of hill slopes. Also included are about 5 percent areas of a soil that has very stony loam over gravelly clay and is underlain by bedrock at a depth of 15 to 20 inches, and about 5 percent areas of Maset soil that are north of the Sprague River.

Permeability is moderate. Roots commonly penetrate to a depth of 12 to 20 inches. Runoff is medium to rapid, and the hazard of erosion is high. Available water capacity is 1.5 to 4 inches. The water-supplying capacity for natural vegetation is 7 to 9 inches.

This soil mainly is used for range, but irrigated and dryland crops are grown in some areas. The soil is better suited to close growing pasture crops, than to other crops because of the high hazard of erosion. Alfalfa hay and cereal hay crops are grown, but yields generally are low. Because most areas of this soil are at a higher elevation than the water supplies, pumping water from wells at lower elevations is needed to irrigate.

This soil is well suited to sprinkler irrigation. Leveling for borders is not feasible because of complex slopes and shallow soil depth. Rate of application of water needs to be carefully adjusted to prevent runoff and erosion. Using crop residue, farming across the slope, and fall chiseling after harvesting cereal hay decrease runoff and soil loss.

The climax native vegetation on this soil (fig. 2) is dominated by Idaho fescue. Several other grasses, for example, basin wildrye and Canby bluegrass, are prominent. A wide variety of perennial forbs occurs throughout the stand. Antelope bitterbrush and big sagebrush are prominent; bitterbrush is the dominant shrub.

If the range site deteriorates, bitterbrush and Idaho fescue decrease. Big sagebrush increases and strongly dominates the stand. If the site severely deteriorates, the bunchgrasses are nearly eliminated and only weeds and annual grasses remain under the brush.

If the range is in poor condition, seedbed preparation and seeding are needed. Intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable for dryland seeding. Plants selected for dryland seeding should be drought resistant and tolerant of cold temperatures. Wildlife values of the total plant community, especially for deer, should be considered in planning management alternatives.

Because of shallow depth to bedrock and excessive slope, this soil has important limitations for such community uses as homesites, small buildings, roads, landfills, and lagoons. Shallow soil depth and excessive slope can cause septic tank absorption fields to function poorly and fail in a few years.

This soil is in capability subclass IVe.

12-Collier loamy sand. This excessively drained soil is on terraces. It formed in very gravelly and sandy alluvium weathered from pumice flows and andesitic rocks. All areas of this soil are woodland. Slopes are 0 to 3 percent. Elevation ranges from 4,300 to 4,525 feet. The average annual precipitation is 20 to 30 inches, the average annual air temperature is 42 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 14 inches thick. The upper part is black loamy sand about 7 inches thick and the lower part is very dark brown, gravelly loamy sand about 7 inches thick. The underlying material is very dark grayish brown, very gravelly sand to a depth of 60 inches or more.

Included with this soil in mapping are about 10 percent areas of Steiger soil and 10 percent of Maklak soil that are mostly less than 2 acres in size. Also included are about 20 percent areas of soil that have only 20 to 35 percent pebbles.

Permeability is rapid. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 4 inches where the soil has a high percentage of hard lava rock fragments and is low in ash and cinders; it is as high as 8 inches where the percentage of hard rock fragments is low and the amount of ash and cinders is high. The water-supplying capacity for natural vegetation is 13 to 19 inches.

This soil is used mainly for timber and wildlife habitat. It is grazed to a limited extent by livestock.

This soil is very well suited to the production of ponderosa pine. Timber is logged without difficulty by tractors, but the thin surface layer is easily disturbed or destroyed by mixing. Deep snow commonly hinders or prevents logging operations from December to March. The survival of pine seedlings planted on this soil may be low because of cold temperatures and, in more gravelly areas, because of low available water capacity. Lodgepole pine and white fir commonly occur in the stand and can be planted for Christmas trees. Roads are easily constructed and maintained on this soil.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is about 30 to 40 percent canopy cover in a moderately stocked mixed-age stand. Lodgepole pine is subordinate. The understory is dominated by Idaho fescue and Ross sedge. Such perennial forbs as strawberry grow in minor amounts. Antelope bitterbrush is the dominant shrub.

As the understory deteriorates, Idaho fescue decreases. Bitterbrush increases for a time; then it decreases. If the understory severely deteriorates or if the soil is disturbed, lodgepole pine increases and dominates the tree cover in places. In this condition, much ground is left bare under the trees.

If the tree overstory is removed through logging or other disturbance, a change in the microclimate occurs. The native grasses temporarily increase and provide considerable forage for a number of years. Seeding of introduced plants generally is not practical because of unmanageable soil conditions related to fertility, soil texture, and frost heaving. Mule deer generally use this community during summer and fall for food and cover.

This soil has few limitations for such community uses as homesites, small buildings, and roads. Septic tank absorption fields function with little difficulty for many years, but there is a hazard of contamination of underground water because of seepage. The soil material is good for roadfill.

This soil is in capability subclass VIc.

13A-Crume loam, 0 to 2 percent slopes. This well drained soil is on terraces. It formed in alluvial and lacustrine sediment weathered mainly from diatomite, tuff, and ash. Soft bedrock is at a depth of 40 to 60 inches. Elevation ranges from 4,200 to 4,400 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 15 inches thick. It has about 10 to 30 percent ash and fine cinders. Small black rounded pebbles of obsidian are scattered over the surface. The subsoil is very dark grayish brown and dark brown clay loam that extends to a depth of about 44 inches. Bedrock of weathered diatomite interbedded with sandstonelike tuff is at a depth of 44 inches.

Included with this soil in mapping are 40 percent areas of soils where depth to bedrock is more than 60 inches, and a few areas of soils along the Sprague River that are very deep and have a gravelly coarse sandy loam substratum at a depth below 25 inches. Also included are a few areas of soils along narrow stream valleys that have a clay loam surface layer and are deeper than 60 inches.

Permeability is moderately slow. Roots commonly penetrate to a depth of 40 to 60 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is as low as 6 inches where depth to soft bedrock is 40 inches and the soil has little ash; it is as high as 14 inches where depth to bedrock is 60 inches and the soil is high in ash. The water-supplying capacity is 12 to 16 inches for natural vegetation and 5 to 8 inches for dryland crops. A water table commonly is at a depth of 3.5 to 5 feet in spring.

This soil is used mainly for range and wildlife habitat. It is also used for a few irrigated and dryland crops, but the choice of crops is limited by the short growing season. Alfalfa hay, cereal hay, and pasture are suitable for irrigated and dryland crops. Oats and rye are grown for cereal hay.

This soil is suited to sprinkler, border, corrugation, and furrow irrigation. Furrows are not used because of the kind of crops that are grown at the present time. Corrugations can be used on slopes of 1 to 2 percent. Deep cuts made in leveling can expose the infertile subsoil. Careful application of water reduces the loss of soluble plant nutrients. Overirrigation can raise the water table above the bedrock. A suitable cropping system consists of 6 to 8 years of alfalfa hay or pasture and 2 years of cereal hay.

The climax native vegetation on this soil is dominated by Idaho fescue. Several other grasses, for example, basin wildrye and Canby bluegrass, are prominent. A wide variety of perennial forbs grows throughout the stand. Antelope bitterbrush and big sagebrush are prominent; bitterbrush is the dominant shrub.

If the range site deteriorates, bitterbrush and Idaho fescue decrease. Big sagebrush increases and strongly dominates the stand. If the site severely deteriorates, the bunchgrasses are nearly eliminated and only weeds and annual grasses remain under the brush.

If the range is in poor condition, seedbed preparation and seeding are needed. Intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable for dryland seeding. Plants for dryland seeding should be drought resistant and tolerant of cold temperatures. Wildlife values of the total plant community, especially for deer, should be considered in planning management alternatives.

Because of low strength and potential frost action, this soil has important limitations for such community uses as homesites, small buildings, and roads. Low strength also is a limitation where the soil material is used for dams and other embankments. Moderately slow permeability and the somewhat limited soil depth can cause septic tank absorption fields to function poorly or fail. A few dwellings have been built on this soil, mainly west of the village of Sprague River.

This soil is in capability subclass IVc.

13B-Crume loam, 2 to 8 percent slopes. This well drained soil is on terraces. It formed in alluvial and lacustrine sediment weathered from diatomite, tuff, and ash. Soft bedrock is at a depth of 40 to 60 inches. Slopes commonly are undulating and very uneven. The average slope is about 3 percent. Elevation ranges from 4,200 to 4,400 feet. The average annual precipitation is 15 to 18 inches, the average annual temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 15 inches thick. It has about 10 to 30 percent pumiceous ash and fine cinders. The subsoil is very dark grayish brown and dark brown clay loam that extends to a depth of about 34 inches. The substratum, to a depth of about 44 inches, is dark brown loam. Bedrock of weathered diatomite interbedded with sandstonelike tuff is at a depth of 44 inches.

Included with this soil in mapping are about 5 percent areas of Choptie soil that has bedrock at a depth of 12 to 20 inches, and about 10 percent areas of soils that are less than 1 acre in size that have bedrock at a depth of 20 to 40 inches. Also included are about 20 percent areas of soils as much as 3 acres in size that have bedrock at a depth of more than 60 inches.

Permeability is moderately slow. Roots commonly penetrate to a depth of 40 to 60 inches. Runoff is slow, and the hazard of erosion is slight under natural conditions, but overirrigation can cause excessive runoff and soil loss. Available water capacity is as low as 6 inches where depth to bedrock is 40 inches and the soil has little ash; it is as high as 14 inches where depth to bedrock is 60 inches and the soil is high in ash. The water-supplying capacity is 12 to 16 inches for natural vegetation, and 5 to 8 inches for dryland crops.

This soil is used mainly for range and wildlife habitat. A few areas are cultivated and are used mainly for dryland crops. The soil is suitable for irrigation but most areas are at a higher elevation than the water supplies. Only a few crops can be grown because of the short growing season. Alfalfa hay, cereal hay, and pasture are suitable for irrigated and dryland crops. Oats and rye are grown for cereal hay.

This soil is better suited to sprinkler irrigation than to other irrigation methods. Deep cuts made in leveling for borders or corrugations expose the infertile subsoil in many places. Bedrock is exposed where such cuts are made on the shallow Choptie soil and on other soils where depth to bedrock is 20 to 40 inches. Careful application of water is needed to prevent soil loss from runoff. Farming across the slope and using crop residue can reduce runoff and erosion where dryland cereal hay is grown. Drainageways between steeper slopes can be seeded to grass to prevent gullying. Permanent pasture, either irrigated or dryland, is well suited to this soil. A suitable cropping system consists of 6 to 8 years of alfalfa hay or pasture and 2 years of cereal hay.

The climax native vegetation on this soil is dominated by Idaho fescue. Several other grasses, for example, basin wildrye and Canby bluegrass, are prominent. A wide variety of perennial forbs occurs throughout the stand. Antelope bitterbrush and big sagebrush are prominent; bitterbrush is the dominant shrub.

If the range site deteriorates, bitterbrush and Idaho fescue decrease, and big sagebrush increases and strongly dominates the stand. If the site severely deteriorates, the bunchgrasses are nearly eliminated and only weeds and annual grasses remain under the brush.

If the range is in poor condition, seedbed preparation and seeding are needed. Intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable for dryland seeding. Plants selected for dryland seeding should be drought resistant and tolerant of cold temperatures. Wildlife values of the total plant community, especially for deer, should be considered in planning management alternatives.

Because of low strength and potential frost action, this soil has important limitations for such community uses as homesites, small buildings, and roads. Low strength also is a limitation where soil materials are used for dams and other embankments. Moderately slow permeability and the somewhat limited soil depth can cause septic tank absorption fields to function poorly or fail. A few homesites are on this soil west of the village of Sprague River.

This soil is in capability subclass IVe.

14B-Crume Variant sandy loam, 2 to 12 percent slopes. This well drained soil is on side slopes of narrow valleys. It formed in a thin mantle of ash underlain by a very gravelly and loamy buried soil. A hardpan is at a depth of 40 to 60 inches. The average slope is about 4 percent. Elevation is 4,350 to 4,400 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is about 16 inches thick. The upper part is very dark grayish brown sandy loam about 7 inches thick, and the lower part is very dark grayish brown, gravelly coarse sandy loam about 9 inches thick. The subsoil extends to a depth of about 42 inches. The upper part is dark brown, gravelly coarse sandy loam to a depth of about 22 inches; the lower part is a buried soil that is dark brown, gravelly clay loam and very gravelly sandy clay loam to a depth of about 42 inches. The surface layer and upper part of the subsoil dominantly are pumiceous ash; the lower part of the subsoil has little ash. An indurated hardpan is at a depth of 42 to 60 inches.

Included with this soil in mapping are about 30 percent areas of soils where depth to hardpan is more than 60 inches, about 5 percent scattered areas of Choptie soil, mainly on tops of low hills, and about 10 percent areas of soil that is underlain by tuff at a depth of about 30 inches.

Permeability is moderately slow. Roots commonly penetrate to a depth of 40 to 60 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is as low as 5.5 inches where the ashy upper part of the soil is 17 inches thick and depth to the hardpan is 40 inches; it is as high as 16 inches where the ashy upper part is 30 inches thick and depth to the hardpan is 60 inches. The water-supplying capacity is 12 to 16 inches for natural vegetation and 5 to 8 inches for dryland crops.

This soil is used mainly for range and wildlife habitat. It is suitable for a few irrigated and dryland crops, but the choice is limited because of the short growing season. Alfalfa hay, cereal hay, and pasture are suited to both irrigated and dryland crops. Oats and rye can be grown for cereal hay. This soil is at a higher elevation than the water supplies.

This soil is suited to sprinkler, border, corrugation, and furrow irrigation. Sprinklers are well suited because of the high water intake rate. Furrow irrigation is not suited to the crops that can be grown at present. Graded borders can be used on slopes to 4 percent. Corrugations are suitable on slopes of as much as 8 percent. The deep cuts that would be needed to level this soil could expose the infertile subsoil in many places and the hardpan and bedrock which underlie the shallow Choptie soil. Careful application of water is needed to prevent soil loss from runoff. Farming across the slope and using crop residue reduce runoff and erosion where cereal hay crops are grown on dryland. Some drainageways can be seeded to grass to prevent the formation of gullies. Permanent pasture, either irrigated or dryland, is well suited to this soil. A suitable cropping system consists of 6 to 8 years of alfalfa hay or pasture and 2 years of cereal hay.

The climax native vegetation on this soil is dominated by Idaho fescue. Several other grasses, for example, basin wildrye and Canby bluegrass, are prominent. A wide variety of perennial forbs occurs throughout the stand. Antelope bitterbrush and big sagebrush are prominent; bitterbrush is the dominant shrub.

If the range site deteriorates, bitterbrush and Idaho fescue decrease. Big sagebrush increases and strongly dominates the stand. If the site severely deteriorates, the bunchgrasses are nearly eliminated and only weeds and annual grasses remain under the brush.

If the range is in poor condition, seedbed preparation and seeding are needed. Intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable for dryland seeding. Plants selected for dryland seeding should be drought resistant and tolerant of cold temperatures. Wildlife values of the total plant community, especially for deer, should be considered in planning management alternatives.

Because of potential frost action and the tendency of the buried soil to shrink and swell on wetting and drying, this soil has limitations for such community uses as homesites, small buildings, and roads. Moderately slow permeability and the somewhat limited soil depth can cause septic tank absorption fields to function poorly or fail in a few years. Piping and seepage limit the use of soil material where the ashy upper part of the soil is used for dams and other embankments.

This soil is in capability subclass IVe.

15E-Dehlinger very stony loam, 15 to 65 percent north slopes. This well drained soil is on long, concave escarpments that predominantly face north. It formed in very gravelly colluvium weathered mainly from basalt, tuff, and andesite. The average slope is about 45 percent. Elevation ranges from 4,100 to 6,000 feet. The average annual precipitation is 12 to 16 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is about 18 inches thick. The upper part is very dark brown, very stony loam about 6 inches thick, and the lower part is very dark grayish brown, extremely gravelly clay loam about 12 inches thick. The subsoil is dark brown and dark yellowish brown, extremely gravelly clay loam to a depth of 60 inches or more.

Included with this soil in mapping are as much as 30 percent areas of Calimus, Capona, and Stukel soils that are below an elevation of 4,700 feet; about 10 percent areas of Lorella soil on shoulder slopes; and about 5 percent small areas of Rock outcrop.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is as low as 4.5 inches where the soil is most gravelly; it is as high as 10 inches where rock fragments make up about 35 percent of the soil content. The water-supplying capacity for natural vegetation is 10 to 13 inches.

This soil mainly is used for range and wildlife habitat. Most areas are too steep to cultivate, but many of the included nonstony patches of Calimus soil can be machine seeded to suitable grasses. Some areas are used as sources of gravel.

The climax native plant community on this soil is dominated by a variety of tall shrubs, for example, western chokeberry, birchleaf mountainmahogany, and serviceberry. Idaho fescue and blue wildrye are prominent in the understory. A variety of perennial forbs occurs throughout the stand.

If the range site deteriorates, Idaho fescue and other desirable bunchgrasses decrease and tall shrubs increase. If the site severely deteriorates, the herbaceous understory is nearly eliminated and much ground under the shrubs is left bare.

Because of very stony soils and steep slopes, seedbed preparation and the seeding of range in poor condition generally is not practical except on the Calimus soil. Following fire, broadcast seeding of intermediate or pubescent wheatgrass before fall rains settle the ash residue is advisable to improve forage production and stabilize the soil. The characteristic shrub cover on this soil provides excellent wildlife habitat, and should be considered when planning management alternatives.

Steepness of slope, stoniness, and outcrops of rock are limitations for such community uses as homesites, small buildings, roads, and sanitary facilities. Few areas of this soil have been used for homesites.

This soil is in capability subclass VIIs.

16E-Dehlinger very stony loam, 15 to 65 percent south slopes. This well drained soil is on long, concave escarpments that face south. It formed in very gravelly colluvium weathered from basalt, tuff, and andesite. The average slope is about 45 percent. Elevation ranges from 4,100 to 6,000 feet. The average annual precipitation is 12 to 16 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is about 18 inches thick. The upper part is very dark brown, very stony loam about 6 inches thick, and the lower part is very dark grayish brown, extremely gravelly clay loam about 12 inches thick. The subsoil is dark brown and dark yellowish brown, extremely gravelly clay loam to a depth of 60 inches or more.

Included with this soil in mapping are about 10 percent areas of Lorella soil on shoulder slopes; about 15 percent areas of Capona, Calimus, and Stukel soils in places below an elevation of 4,700 feet, and about 10 percent areas of exposed bedrock, rock ledges, rimrock, talus, and rock streams. Rimrock commonly marks the upper boundary of this map unit.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is as low as 4.5 inches where the soil is most gravelly; it is as high as 10 inches where rock fragments average about 35 percent of the soil content. The water-supplying capacity for natural vegetation is about 10 to 13 inches.

This soil is too stony and rocky and too steep to cultivate in nearly all places. The main use is for range and wildlife habitat. Many areas provide good sources of gravel.

The climax native vegetation on this soil (fig. 3) is a plant community dominated by western juniper that has about 10 percent canopy cover. Bluebunch wheatgrass is the dominant understory grass. A variety of perennial forbs occurs throughout the stand. Big sagebrush and antelope bitterbrush are common. Shrubs generally are sparse; however, around rock talus and rock outcrops they are prominent.

If the range site deteriorates, bluebunch wheatgrass and other desirable grasses decrease and big sagebrush increases and dominates the shrub understory. If the site severely deteriorates and if there has been recurring fire, juniper is nearly eliminated. In this condition, rubber rabbitbrush and big sagebrush dominate the range site, much ground is left bare, and the hazard of soil erosion is high.

Because of very stony soils and steep slopes, seedbed preparation and seeding of poor condition range are generally not practical. Wildlife values, especially food and cover needs for deer winter range, should be considered in planning management alternatives.

Because of steepness of slope, stoniness, and intermittent rock outcrops, this soil has important limitations for such community uses as homesites, small buildings, roads, and sanitary facilities. Few areas of this soil have been used for homesites.

This soil is in capability subclass VIIs.

17A-Deter clay loam, 0 to 2 percent slopes. This well drained soil is on low terraces. It formed in clayey sediment weathered from tuff, diatomite, and basalt. Most areas of the soil were leveled for irrigation. Elevation is 4,100 to 4,200 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is about 80 to 110 days.

Typically, the surface layer is very dark brown clay loam about 8 inches thick. The upper part of the subsoil is very dark brown and very dark grayish brown clay that extends to a depth of about 35 inches; the lower part is very dark grayish brown clay loam to a depth of 60 inches or more.

Included with this soil in mapping is an area of soil in the south end of Langell Valley that is silty clay and clay throughout the profile, which forms deep, wide cracks on drying. Also included are about 10 percent areas of Lakeview soil that are about 0.5 acre to 2 acres in size, and a few areas of soils along the Lost River that have a subsoil of heavy clay loam.

Permeability is slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is about 8.5 to 11 inches. A water table, which mostly results from irrigation, is at a depth of 2.5 to 6 feet during spring and summer.

This soil is used mainly for irrigated crops, for example, alfalfa hay, wheat, oats, barley, cereal hay, and pasture. Oats mainly are grown for cereal hay. Irish potatoes are not grown because of the clayey texture of the soil. Yield of alfalfa hay is about one-third less for this soil than yields obtained on the well drained loamy and sandy soils in the survey area.

This soil is suited to border, furrow, corrugation, and sprinkler irrigation. Furrow irrigation commonly is not suited to the crops that are grown at present. Corrugations are suitable on slopes of 1 to 2 percent. Sprinkler systems require careful design to prevent ponding and runoff that may result from the low water intake rate. Cuts of more than about 1 foot made in leveling expose the clayey subsoil. Overirrigation can raise the water table and cause damage to crops from waterlogging and submergence. Deep drains commonly are needed to lower the water table below the root zone of crops. Tail water at the ends of borders and corrugations can be disposed of in lower drains to prevent crop damage from submergence. Because of much clay in the surface layer, tillage is difficult, and crops need to be cultivated within a narrow range of moisture content. Spring cultivation may be delayed until the surface layer has dried somewhat. Permanent pasture or a cropping system of 5 or 6 years of alfalfa hay and 1 or 2 years of grain is well suited to this soil. Use of crop residue improves soil structure and tilth.

Because of low strength and the tendency to shrink and swell considerably on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. These characteristics also limit the use of the soil material for dams and other embankments. Slow permeability can cause septic tank absorption fields to function poorly or fail in a few years. A few areas of this soil are used for homesites.

This soil is in capability subclass IIw.

17B-Deter clay loam, 2 to 7 percent slopes. This well drained soil is on terraces. It formed in clayey sediment weathered from tuff, diatomite, and basalt. The average slope is about 4 percent. Elevation ranges from 4,100 to 4,200 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is about 80 to 110 days.

Typically, the surface layer is very dark brown clay loam about 8 inches thick. The upper part of the subsoil is very dark brown and very dark grayish brown clay that extends to a depth of about 35 inches; the lower part is very dark grayish brown clay loam to a depth of 60 inches or more.

Included with this soil in mapping are about 10 percent areas of soils that have siltstone, diatomite, or basaltic bedrock at a depth of 40 to 60 inches; and a few areas of soils near springs that are mottled at a depth below 20 inches. Also included are a few areas of soils where the surface is slightly stony in spots and a few areas of soils that have a heavy clay loam and clay surface layer which form deep, wide cracks on drying.

Permeability is slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is about 8.5 to 11 inches.

This soil is used mainly for irrigated crops, for example, alfalfa hay, wheat, oats, barley, cereal hay, and pasture. Oats mainly are grown for cereal hay. Irish potatoes are not grown because of the clayey texture of the soil. Yield of alfalfa hay is about one-third less for this soil than yields obtained on the well drained loamy or sandy soils in the survey area.

This soil is suited to border, furrow, corrugation, and sprinkler irrigation. Furrow irrigation commonly is not suited to the crops that are grown at present. Borders are suitable on slopes that range to 4 percent. Sprinkler systems require very careful design to prevent runoff that can cause erosion and soil loss. Careful irrigation is needed to prevent erosion. Leveling for borders and corrugations commonly requires deep cuts that expose the clayey subsoil in many places. Tillage is difficult because of much clay in the surface layer and crops need to be cultivated within a narrow range of moisture. Spring cultivation may be delayed until the surface layer has dried somewhat. Permanent pasture or a cropping system of 5 or 6 years of alfalfa hay and 1 year of grain is well suited to this soil. Use of grain crop residue helps reduce runoff and erosion and improves soil structure and tilth.

Because of low strength and a tendency to shrink and swell considerably on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. These characteristics also limit the use of soil material for dams and other embankments. Slow permeability can cause septic tank absorption fields to function poorly or fail in a few years. A few areas of this soil are used for homesites.

This soil is in capability subclass IIe.

18A-Dodes loam, 0 to 2 percent slopes. This well drained soil is on terraces and rock benches. It formed in material weathered from tuffaceous sandstone, tuffaceous breccia, diatomite, and basalt. Elevation ranges from 4,100 to 4,400 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown loam about 12 inches thick. The subsoil is very dark grayish brown and dark brown clay loam to a depth of about 22 inches. Partially weathered sandy tuff interbedded with diatomite is at a depth of about 22 inches.

Included with this soil in mapping are about 10 percent areas of Harriman soil that are mostly less than 2 acres in size, and about 5 percent areas of Modoc soil. Also included are about 2 percent areas of soils that have a mildly alkaline or moderately alkaline surface layer.

Permeability is moderately slow. Roots mostly penetrate to a depth of 20 to 40 inches; and a few very fine roots penetrate small cracks in the bedrock. Runoff is slow, and the hazard of erosion is slight. Available water capacity is as low as 3 inches where depth to bedrock is 20 inches and the subsoil is gravelly; it is as high as 8 inches where depth to bedrock is 40 inches and few pebbles are present. A water table is mostly present above bedrock during the period of irrigation.

This soil is used mainly for irrigated crops, for example, wheat, oats, barley, alfalfa hay, cereal hay, and pasture. Oats generally are grown for cereal hay: Irish potatoes are not grown mainly because of the high content of clay in the subsoil. A few areas that are at a higher elevation than the water supplies are used for dryland pasture.

This soil is suited to sprinkler, graded border, and furrow irrigation. Corrugations also can be used on slopes of 1 to 2 percent. Furrows generally are not used unless potatoes are grown. Cuts made in leveling for borders and furrows expose bedrock in many places. Sprinkler systems are better suited to this soil than other irrigation systems. They afford accurate control of soil moisture for crops, and do not require extensive land preparation. Overirrigation by any method raises the water table above bedrock and causes crop damage from waterlogging. Tail water from borders and furrows can be disposed of in lower drains to prevent damage to crops from submergence. Permanent pasture or cropping system of 5 or 6 years of alfalfa hay and 1 or 2 years of grain is well suited to this soil.

Because of low strength, moderate depth to bedrock, and a tendency of the subsoil to shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. Moderately slow permeability and moderate soil depth can cause septic tank absorption fields to function poorly or fail. Seepage is a limitation where lagoons and reservoirs are placed on this soil because of moderate depth to bedrock. This soil is not a good source of material for topsoil and roadfill because of the limited material available and the difficulty in restoring cut areas to vegetation. Many homesites are on this soil.

This soil is in capability subclass IIIs.

18B-Dodes loam, 2 to 15 percent slopes. This well drained soil is on terraces and rock benches near the edge of basins. It formed in material weathered from tuffaceous sandstone, tuffaceous breccia, diatomite, and basalt. Elevation ranges from 4,100 to 4,400 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown loam about 12 inches thick. The subsoil is very dark grayish brown and dark brown clay loam to a depth of 22 inches. Partially weathered sandy tuff interbedded with diatomite is at a depth of 22 inches.

Included with this soil in mapping are areas of Stukel, Harriman, and Capona soils, each of which makes up about 5 percent of the map unit; and about 5 to 10 percent areas of very stony Lorella soil that are about 1 acre to 3 acres in size.

Permeability is moderately slow. Roots mostly penetrate to a depth of 20 to 40 inches, but a few very fine roots penetrate cracks in the bedrock. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is as low as 3 inches where depth to bedrock is 20 inches and the subsoil is gravelly; it is as high as 8 inches where bedrock is at a depth of 40 inches and few pebbles are present. The water-supplying capacity is 9 to 13 inches for natural vegetation, and 5 to 9 inches for dryland crops.

This soil is used for irrigated crops, for example, wheat, oats, barley, alfalfa hay, cereal hay, and pasture. It is also used for dryland crops and for range. Many areas are at a higher elevation than the water supplies. Oats are grown mainly for cereal hay. Irish potatoes are not grown mainly because of excessive slope and the high content of clay in the subsoil. On dryland, wheat can be grown following summer fallow.

This soil is better suited to sprinkler irrigation than to other irrigation methods. Leveling for borders and furrows requires deep cuts that expose bedrock in many places. A few areas are irrigated by uncontrolled flooding. Because some areas of this soil are at a higher elevation than the water supplies, pumping water upslope from canals or ditches is needed to irrigate. Careful irrigation is needed to prevent erosion from runoff. Drainageways between some slopes need to be seeded to grass to prevent the formation of gullies. Permanent pasture or a cropping system that uses close growing plants most of the time is well suited to this soil. Under irrigation, a cropping system of 5 or 6 years of alfalfa and 2 years of grain is suitable where cross slope tillage and other practices are used to reduce erosion. Farming across the slope, fall chiseling after harvest, and using crop residue reduce erosion from runoff and increase the amount of moisture stored for crop use on dryland.

The climax native vegetation on this soil is a plant community dominated by western juniper that has about 10 to 15 percent canopy cover. Bluebunch wheatgrass is the dominant understory grass. Idaho fescue and Sandberg bluegrass are prominent. A variety of perennial forbs occurs throughout the stand. Antelope bitterbrush and lesser amounts of big sagebrush are the dominant shrubs.

If the range site deteriorates, bluebunch wheatgrass, Idaho fescue, and bitterbrush decrease and forbs, big sagebrush, and juniper increase. If the site severely deteriorates, the bunchgrasses and desirable shrubs, including big sagebrush, are nearly eliminated. In this condition, much ground is left bare under the juniper, and the hazard of soil erosion is high. If deterioration is a result of recurring fire, juniper is nearly eliminated, and low value shrubs dominate the range site.

Seedbed preparation and seeding are needed on this soil if the range is in poor condition. Crested wheatgrass and ladak alfalfa are suitable for dryland seeding. Wildlife values, especially food and cover needs for deer winter range, should be considered in planning management alternatives.

Because of low strength, moderate depth to bedrock, and a tendency of the subsoil to shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. Moderately slow permeability and moderate soil depth can cause septic tank absorption fields to function poorly or fail. Because of moderate depth to bedrock, seepage can be a problem where lagoons and reservoirs are placed on this soil. Slopes of more than 7 percent are excessive for lagoons. This soil is not a good source of material for topsoil and roadfill because of limited material available and the difficulty in restoring cut areas to vegetation. Many homesites are on this soil.

This soil is in capability subclass IVe.

19A-Fordney loamy fine sand, 0 to 2 percent slopes. This excessively drained soil is on terraces. It formed in alluvial lacustrine sediment weathered mainly from tuff. Most areas of this soil that were leveled for irrigation are a part of suburban areas near Klamath Falls. Elevation ranges from 4,050 to 4,180 feet. The average annual precipitation is about 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark grayish brown loamy fine sand about 8 inches thick. The underlying material is very dark grayish brown loamy sand.

Included with this soil in mapping are about 5 percent areas of Poe soil that are mainly less than 1 acre in size; about 5 percent areas of Henley and Laki soils, and many areas of soils where thin lenses and layers of loam, fine sandy loam, and sandy clay loam that are about 1 inch to 5 inches thick are at a depth of 10 to 40 inches. Also included are about 15 percent areas of soils that are underlain by a hardpan at a depth of 40 to 65 inches. In these soils, firm, weakly cemented nodules about 0.5 inch to 1.5 inches in diameter are at a depth below 30 inches in places.

Permeability is rapid. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. There is a moderate hazard of wind erosion in spring when windspeed is high and the surface layer becomes dry. Available water capacity is about 5.5 to 8.5 inches. A water table caused mostly by overirrigation is at a depth of 2 to 6 feet. For most of the area the water table is at a depth of 3.5 to 5 feet during the period of irrigation. Seepage from unlined canals and ditches raises the water table. The surface layer is medium acid and strongly acid in areas of soils that have been irrigated for many years and heavily fertilized for potatoes.

This soil is used for irrigated crops, for example, Irish potatoes (fig. 4), alfalfa hay, wheat, oats, barley, cereal hay, and pasture. Oats mainly are grown for cereal hay. This soil is the main potato-producing soil in the survey area. Potatoes commonly are of very high quality and good size, and are easily cleaned. Yields of small grain and cereal hay are not as high as yields on the well drained loamy soils in the survey area. Areas of this soil near Bly Mountain are irrigated, and ponderosa pine and lodgepole pine nursery stock are grown. A few areas, mainly in the northern end of Yonna Valley, are irrigated from wells.

This soil is better suited to sprinkler irrigation than to other irrigation methods because of the high water intake rate. Large quantities of water need to be applied to irrigate the lower end of borders and furrows. Excess water that is not used by crops raises the water table. Comparatively deep cuts can be made in leveling without exposing layers of contrasting texture and fertility. Rate of application of water needs to be carefully adjusted with sprinklers to supply proper moisture to crops without raising the water table. Overirrigation can readily leach plant nutrients, including nitrogen, below the root zone of crops. Little or no runoff occurs with any method of irrigation, and tail water disposal is not a concern. Much seepage can be prevented by lining canals and ditches that cross this soil. Deep drains are needed to lower the water table in overirrigated areas.

Strongly alkali or very strongly alkali spots can be treated with gypsum or sulfur to reduce sodium. Use of grain crop residue and conducting tillage and other farming practices at right angles to prevailing winds reduce wind erosion. Permanent pasture or a cropping system of 5 or 6 years of alfalfa hay, 1 or 2 years of potatoes, and 1 year of grain is well suited to this soil.

Because of wetness, this soil has limitations for such community uses as homesites, small buildings, and roads. Seepage and piping also limit the use of soil material for dams and other embankments. Windblown sand accumulates on roads in places. The depth to which shallow excavations can be made is limited somewhat by the water table and by caving of the sandy cutbanks. Septic tank absorption fields may function poorly because of soil wetness, and contamination of ground water is a hazard. Seepage and contamination of ground water are limitations to the construction of lagoons on this soil. Many areas of this soil are used for homesites.

This soil is in capability subclass IIIw.

19C-Fordney loamy fine sand, 2 to 20 percent slopes. This excessively drained soil is on terraces and south-facing escarpments near the edge of warmer basins. It formed in lacustrine sediment weathered mainly from tuff. The average slope is about 5 percent. Elevation ranges from 4,100 to 4,500 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark grayish brown loamy fine sand about 8 inches thick. The underlying material is very dark grayish brown loamy sand to a depth of 60 inches or more.

Included with this soil in mapping are many areas of Calimus fine sandy loam that are mainly less than 2 acres in size. In most areas this soil makes up about 10 percent of the map unit, but in a few areas it makes up as much as 30 percent. Scattered areas of stony or very stony patches are near the upper edges of a few escarpments.

Permeability is rapid. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of water erosion is slight. There is a moderate hazard of wind erosion in spring in areas that are barren of vegetation. Available water capacity is about 5.5 to 8.5 inches. Seepage from unlined canals and ditches adds to buildup of the water table in the lower Fordney soil. The water-supplying capacity for natural vegetation is 10 to 13 inches.

This soil is used for irrigated crops, for example, alfalfa hay, wheat, oats, barley, cereal hay, and pasture. Irish potatoes are grown where slope is less than 5 percent.

Potatoes commonly are of very high quality and good size and are easily cleaned. Yields of small grain and cereal hay are not as high as yields on the well drained loamy soils in the survey area. If this soil is not irrigated, the main use is for range. Because many areas of this soil are at a higher elevation than the water supplies, pumping water upslope from canals or ditches is needed to irrigate. A few areas are irrigated from wells.

This soil is better suited to sprinkler irrigation than to other irrigation methods because of the high water intake rate. Large quantities of water need to be applied to irrigate the lower end of borders and furrows. Excess water that is not used by crops raises the water table in the lower Fordney soil. Borders can be used on slopes of as much as 4 percent. Furrows can be used on slopes of as much as 8 percent if the furrow slope does not exceed 2 percent. Very short border and furrow lengths are needed so that water can reach the end of runs without overirrigating the upper part. Comparatively deep cuts can be made in leveling without exposing layers of contrasting texture and fertility. Rate of application of water needs to be carefully adjusted with sprinklers to supply the proper moisture to crops. Excessive irrigation can readily leach plant nutrients, including nitrogen, below the root zone of crops. Little or no runoff occurs with any method of irrigation, and tail water disposal is not a concern. Much seepage can be prevented by lining canals and ditches that cross the soil.

Use of grain crop residue and conducting tillage and other farming practices at right angles to prevailing winds reduce wind erosion. Permanent pasture or a cropping system of 6 to 8 years of alfalfa hay and pasture and 2 years of grain is well suited to this soil. If the slope is less than 5 percent, the cropping system can include 1 year or 2 years of potatoes.

The climax native plant community on this soil is dominated by Indian ricegrass and Thurber needlegrass. Idaho fescue and Ross sedge are prominent. A few perennial forbs are in the stand. Such desirable shrubs as antelope bitterbrush and Klamath plum are prominent.

If the range deteriorates, Indian ricegrass and bitterbrush decrease and big sagebrush and less desirable bunchgrasses increase. If the site severely deteriorates, big sagebrush and rubber rabbitbrush strongly dominate the plant composition, and much ground is left bare under the shrubs.

If the range is in poor condition, seedbed preparation and seeding are needed. Crested wheatgrass and alfalfa are suitable for dryland seeding. Plants for dryland seeding need to have deep penetrating root systems and be drought resistant.

This soil is well suited to many community uses if slopes are not excessive. Few problems arise in the construction of homesites, small buildings, and roads if slopes are less than 8 percent. Considerable excavation is needed where homesites, buildings, and roads are constructed on steeper slopes. Septic tank absorption fields can function satisfactorily for many years if slope is not excessive. Seepage and excessive slope are severe limitations for lagoons. Many areas of this soil are used for homesites and small buildings.

This soil is in capability subclass IVe.

20A-Fordney loamy fine sand, terrace, 0 to 3 percent slopes. This excessively drained soil is on terraces that are slightly higher than the adjacent, nearly level Fordney soils. It formed in lacustrine sediment weathered mainly from tuff. In most places the surface is uneven or undulating. Elevation ranges from about 4,080 to 4,200 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark grayish brown loamy fine sand about 8 inches thick. The underlying material is very dark grayish brown loamy sand to a depth of 60 inches or more.

Included with this soil in mapping are about 15 percent areas of Calimus fine sandy loam that are mainly less than 1 acre in size.

Permeability is rapid. Roots commonly penetrate to a depth of 60 inches or more. Runoff is very slow, and the hazard of water erosion is slight. There is a moderate hazard of wind erosion in spring when windspeed is high and the surface layer dries. Available water capacity is about 5.5 to 8.5 inches. Irrigation and seepage from unlined canals and ditches add to raising the water table in the lower Fordney soil.

This soil is used for irrigated crops, for example, Irish potatoes, alfalfa hay, wheat, oats, barley, cereal hay, and pasture. Oats mainly are grown for cereal hay. Potatoes are one of the main crops. They commonly are of very high quality and good size and are easily cleaned. Yields of small grain and cereal hay are not as high as yields on the well drained loamy soils in the survey area.

Some areas of this soil that are at a higher elevation than the irrigation canals can be irrigated by pumping water from them; other areas can be irrigated from wells. This soil is better suited to sprinkler irrigation than to other irrigation methods because of the high water intake rate and uneven surface. Large quantities of water need to be applied to irrigate the lower end of borders and furrows. Excess water that is not used by crops raises the water table in the lower Fordney soil. Very short border and furrow lengths are needed for water to reach the end of runs without excessive irrigation of the upper part. Comparatively deep cuts can be made in leveling without exposing layers of contrasting texture and fertility. Rate of application of water needs to be carefully adjusted with sprinklers to supply proper moisture to crops without leaching plant nutrients, including nitrogen, below the root zone of crops. Little or no runoff occurs with any method of irrigation, and tail water disposal is not a concern. Much seepage can be prevented by lining ditches that cross this soil.

Use of grain crop residue and conducting tillage operations and other farming practices at right angles to prevailing winds reduces wind erosion. Permanent pasture or a cropping system of 5 or 6 years of alfalfa hay, 1 or 2 years of potatoes, and 1 year of grain is well suited to this soil.

This soil is well suited to such community uses as homesites, small buildings, and roads. Windblown sand which accumulates on roads and at road edges must be removed in places. The depth to which shallow excavations can be made is limited mostly by caving of the sandy cutbanks. Septic tank absorption fields function satisfactorily over a period of many years. Seepage is a severe limitation for the operation of sewage lagoons.

This soil is in capability subclass IIIe.

21E-Fuego-Rock outcrop complex, 5 to 40 percent slopes. This complex mainly consists of areas of Fuego soil intermingled with spots and ledges of exposed bedrock. It is on volcanic domes in the Sprague River Valley and the south slopes of Medicine Mountain. The somewhat excessively drained Fuego soil formed in material weathered from felsitic rocks and mostly occurs in narrow bands between vertical ledges of lava bedrock. It is underlain by bedrock at a depth of 20 to 40 inches. Elevation ranges from 4,300 to 6,000 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 42 to 45 degrees F, and the frost-free season is 50 to 70 days.

This complex is about 55 percent Fuego very stony sandy loam, 5 to 40 percent slopes, and about 25 percent spots and ledges of Rock outcrop. Also included are about 10 percent Maset coarse sandy loam, 12 to 45 percent north slopes, and about 10 percent shallow very stony loam.

Typically, the Fuego soil has a surface layer about 10 inches thick. The upper part is very dark grayish brown, very stony sandy loam about 5 inches thick, and the lower part is very gravelly sandy loam about 5 inches thick. The subsoil is dark brown, very gravelly sandy loam to a depth of about 25 inches. Hard lava bedrock is at a depth of 25 inches.

Permeability is moderately rapid in the Fuego soil. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is as low as 2 inches where depth to bedrock is 20 inches; it is as high as 6 inches where depth to bedrock is 40 inches. The water-supplying capacity for natural vegetation is 7 to 11 inches.

Rock outcrop commonly occurs as long, narrow ledges or lips that ascend in steplike fashion to the top of the dome or hill.

This complex is used for range, wildlife habitat, and to a limited extent, for production of timber. It is poorly suited to the production of ponderosa pine. Harvesting of trees by tractor logging is difficult because of the nearly vertical faces of rock ledges and other Rock outcrop. The soil commonly is too wet or the snow too deep for logging from December to March. Pine seedlings have a low rate of survival because of severe plant competition.

The climax native vegetation on this soil is a plant community dominated by ponderosa pine and western juniper. The understory is dominated by bluebunch wheatgrass and antelope bitterbrush. A variety of perennial forbs occurs throughout the stand.

If the range site deteriorates, bluebunch wheatgrass and bitterbrush decrease and young juniper and low value shrubs increase. In this condition, curlleaf mountainmahogany, a desirable shrub, increases for a time; then it decreases. If the site severely deteriorates, juniper and a few scattered pine trees dominate the tree overstory, much ground is left bare, and the hazard of soil erosion is high.

Because of stony soils, seedbed preparation and seeding of poor condition range are generally not practical. Following fire or other disturbance, broadcast seeding of intermediate or pubescent wheatgrass before fall rains settle the ash layer is advisable to improve forage production and to stabilize the soil. Wildlife values, especially food and cover needs for deer winter range, should be considered in planning management alternatives.

Because of soil depth, steepness of slope, and the large amount of Rock outcrop, this soil has important limitations for such community uses as homesites, small buildings, and roads. Seepage is a severe limitation for landfills. This complex is a poor source of roadfill because of limited material available and the difficulty in reestablishing vegetation in cut areas. Soil depth and excessive slope can cause septic tank absorption fields to function poorly or fail. No homesites or other structures are on this complex.

This complex is in capability subclass VIIs.

22A-Harriman loamy fine sand, 0 to 2 percent slopes. This well drained soil is on terraces. It formed in lacustrine sediment weathered from diatomite and tuff and a thin overwash of loamy fine sand. Brittle lacustrine material commonly is at a depth of 40 to 60 inches. All areas of this soil were leveled for irrigation. Elevation ranges from about 4,100 to 4,200 feet. The average annual precipitation is 12 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is 16 inches thick. The upper part is very dark grayish brown loamy fine sand about 9 inches thick, and the lower part is very dark grayish brown fine sandy loam about 7 inches thick. The subsoil is very dark grayish brown or dark brown clay loam that extends to a depth of about 36 inches. The substratum is dark brown sandy clay loam to a depth of about 42 inches over firm and brittle lacustrine material to a depth of 60 inches or more.

Included with this soil in mapping are 30 percent areas of soils where depth to the firm and brittle lacustrine substratum is more than 60 inches and about 15 percent areas of Fordney soil that are mostly less than 3 acres in size.

Permeability is moderately slow. Roots penetrate to a depth of 40 to 60 inches. Runoff is very slow, and the hazard of water erosion is slight. There is a moderate hazard of soil blowing in spring when the surface layer dries and windspeed is high. Available water capacity is about 8 to 10 inches. A water table is at a depth of 2.5 to 6 feet during the period of irrigation.

This soil is used mainly for irrigated crops, for example, Irish potatoes, alfalfa hay, wheat, oats, barley, pasture, and cereal hay. Oats mainly are grown for cereal hay. Potatoes are well suited to this soil. They commonly are of high quality and good size and are easily cleaned.

This soil is better suited to sprinkler irrigation than to other irrigation methods because of the high water intake rate. Comparatively large amounts of water need to be applied to reach the lower end of borders and furrows, and the sandy upper part of the soil can be temporarily waterlogged if overirrigated. Excess water raises the water table. Leveling where cuts of more than about 1 foot are made exposes the relatively infertile subsoil. Rate of application of water needs to be carefully adjusted with sprinklers to supply the proper amount of moisture for crop use without raising the water table. Overirrigation on this soil can readily leach plant nutrients, including nitrogen, below the root zone of crops. Little or no runoff occurs with any method of irrigation used, and tail water disposal ordinarily is not a concern. Deep drains are needed to lower the water table in areas that are overirrigated.

Use of grain crop residue and conducting tillage and other farming practices at right angles to prevailing winds can reduce wind erosion. A cropping system of 5 or 6 years of alfalfa hay, 1 or 2 years of potatoes, and 1 year of grain is well suited to this soil.

Because of low strength, potential frost action, and the tendency of the subsoil to shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. Wetness also is a limitation for dwellings with basements, landfills, and excavations. Moderately slow permeability and wetness can cause septic tank absorption fields to function poorly and fail in a few years. Seepage and wetness are limitations for lagoons. Many rural homesites are on this soil.

This soil is in capability subclass IIIe.

23A-Harriman loam, 0 to 2 percent slopes. This well drained soil is on terraces mainly near the edge of warmer basins. It formed in lacustrine sediment weathered from diatomite, tuff, and basalt. Lacustrine bedrock is at a depth of 40 to 60 inches. Nearly all areas of this soil were leveled for irrigation. Elevation ranges from about 4,100 to 4,200 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown loam about 18 inches thick. The subsoil extends to a depth of about 48 inches. The upper part, to a depth of about 42 inches, is very dark grayish brown or dark brown clay loam; the lower part, to a depth of about 48 inches, is dark brown sandy clay loam. Extremely firm, lacustrine bedrock is at a depth of 48 inches.

Included with this soil in mapping are about 5 percent areas of Calimus and Modoc soils that are mostly less than 1 acre in size and about 5 percent areas of Laki soil that are calcareous and moderately alkaline to strongly alkaline. Also included are about 30 percent areas of soils in which depth to diatomite, lacustrine tuff, or very firm and compact lake sediment is more than 60 inches and few other areas where the soil dominantly is deeper than 60 inches.

Permeability is moderately slow. Roots commonly penetrate to a depth of 40 to 60 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is as low as 7 inches where depth to restricting layers is about 40 inches and the subsoil has many pebbles; it is as high as 12 inches where soil depth is 60 inches and there are few pebbles in the subsoil. A water table caused mostly by irrigation is at a depth of 2.5 to 6 feet.

This soil is used mainly for irrigated crops, for example, alfalfa hay, wheat, barley, oats, pasture, cereal hay, and Irish potatoes. Oats are grown mainly for cereal hay. Although yield of potatoes is higher than yields for most sandy soils in the survey area, the size generally is smaller and the potatoes are more difficult to clean than those grown on sandy soils. A few areas of this soil, mainly in Langell Valley, do not have developed water supplies and these areas are used for dryland pasture crops. Crested wheatgrass, intermediate wheatgrass, and alfalfa can be grown on dryland.

This soil is suited to sprinkler, graded border, and furrow irrigation. Leveling where cuts of as much as 2 feet are made exposes the infertile subsoil in many places. Sprinklers afford the most accurate control of soil moisture for potatoes and other crops and help prevent raising of the water table. Deep drains are needed to lower the water table below the root zone of crops if excessively irrigated. Tail water from borders and furrows can be disposed of in drains to prevent crop damage from water-logging.

A tillage pan can form in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent formation of such a pan. Slick spots and persistent spots of alkali can be treated with sulfur or gypsum. Use of grain and other crop residue improve tilth and soil structure. A cropping system of 5 or 6 years of alfalfa hay, 2 years of potatoes, and 1 year of grain is well suited to this soil if it is irrigated. Wheat can be grown following summer fallow on dryland. A suitable cropping system for dryland consists of several years of alfalfa, summer fallow, and wheat.

Because of low strength, potential frost action, and a tendency of the subsoil to shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. Wetness also is a limitation for dwellings with basements, for landfills, and for excavations. Moderately slow permeability and wetness can cause septic tank absorption fields to function poorly and fail in a few years. Wetness also is a limitation for lagoons. Many homesites are on this soil, and a large industrial complex was built on it along the Klamath River.

This soil is in capability subclass IIc.

23B-Harriman loam, 2 to 5 percent slopes. This well drained soil is on terraces near the edge of warmer basins. It formed in lacustrine sediment weathered mainly from diatomite, tuff, and basalt. Lacustrine bedrock is at a depth of 40 to 60 inches. Elevation ranges from about 4,100 to 4,500 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown loam about 18 inches thick. The subsoil extends to a depth of about 48 inches. The upper part, to a depth of 42 inches, is very dark grayish brown or dark brown clay loam; the lower part, to a depth of about 48 inches, is dark brown sandy clay loam. Extremely firm, lacustrine bedrock is at a depth of 48 inches.

Included with this soil in mapping are about 10 percent areas of Dodes soil and 10 percent of Calimus soil; about 5 percent areas of very stony Lorella soil near escarpments that are mainly about 0.5 acre to 2 acres in size; and about 30 percent areas of soils in which depth to diatomite, lacustrine tuff, and very firm and compact lake sediment is more than 60 inches. Also included are a few areas where the soil dominantly is deeper than 60 inches.

Permeability is moderately slow. Roots commonly penetrate to a depth of 40 to 60 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is as low as 7 inches where depth to restricting layers is about 40 inches and the subsoil has many pebbles; it is as high as 12 inches where soil depth is 60 inches and the subsoil has few pebbles. A water table commonly is perched a few inches above bedrock following heavy irrigation. The water-supplying capacity for dryland crops is about 10 inches.

This soil is used mainly for irrigated crops, for example, alfalfa hay, wheat, barley, oats, pasture, cereal hay, and Irish potatoes. Oats are mainly grown for cereal hay. Although total yield of potatoes is higher than yield for most soils in the survey area, the potatoes generally are smaller and are more difficult to clean than potatoes grown on sandy soils. Some dryland crops, for example, alfalfa, wheat, and pasture crops, are grown in areas that are at a higher elevation than the water supplies. Crested wheatgrass and intermediate wheatgrass are used for dryland pasture.

This soil is better suited to sprinkler irrigation than to other irrigation methods. Leveled areas can be irrigated by graded borders on slopes of as much as 4 percent, and by furrows across the slope if slopes do not exceed 2 percent. Corrugations also can be used to irrigate. Very deep cuts for leveling are commonly required for borders, furrows, and corrugations. Leveling where cuts of more than 2 feet are made exposes the infertile subsoil in many places. Thinner cuts expose bedrock on the Dodes and Lorella soils. Sprinklers do not require extensive land preparation and afford the most accurate control of soil moisture for potatoes and other crops. Rate of application of water needs to be carefully adjusted to prevent erosion with any irrigation method. Because some areas are at a higher elevation than the water supplies, pumping water upslope from canals, ditches, or wells is needed to irrigate.

A tillage pan can form in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent formation of such a pan. Use of grain and other crop residue improve tilth and soil structure. If the soil is irrigated, a suitable cropping system consists of 5 or 6 years of alfalfa hay, 1 or 2 years of potatoes, and 1 year of grain. Permanent pasture also is well suited to this soil. A suitable cropping system for dryland consists of several years of alfalfa, summer fallow, and wheat. Using crop residue, farming across the slope, and fall chiseling after harvest decrease runoff and soil loss from erosion and increase moisture available for future crops.

Because of low strength, potential frost action, and a tendency of the subsoil to shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. Moderately slow permeability can cause septic tank absorption fields to function poorly and fail in a few years. Many areas of this soil are used for homesites in suburban and rural areas.

This soil is in capability subclass IIe.

23C-Harriman loam, 5 to 15 percent slopes. This well drained soil is on terraces near the edge of warmer basins and below escarpments. It formed in lacustrine sediment weathered from diatomite, tuff, and basalt. Lacustrine bedrock is at a depth of 40 to 60 inches. Elevation ranges from about 4,100 to 4,500 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown loam about 18 inches thick. The subsoil extends to a depth of about 48 inches. The upper part, to a depth of about 42 inches, is very dark grayish brown or dark brown clay loam; the lower part, to a depth of about 48 inches, is dark brown sandy clay loam. Extremely firm, lacustrine bedrock is at a depth of 48 inches.

Included with this soil in mapping are about 10 percent areas of Calimus soil and 10 percent of Dodes soil and about 5 percent areas of very stony Lorella soil near escarpments that are about 1 acre to 3 acres in size. Also included are a few areas where the soil predominantly is deeper than 60 inches.

Permeability is moderately slow. Roots commonly penetrate to a depth of 40 to 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is as low as 7 inches where depth to bedrock is about 40 inches and the subsoil has many pebbles; it is as high as 12 inches where soil depth is 60 inches and the subsoil has few pebbles. The water-supplying capacity for natural vegetation is 11 to 13 inches.

This soil is used mainly for irrigated and dryland crops, for example, alfalfa hay, pasture, wheat, oats, barley, and cereal hay. The soil mostly is too steep to grow Irish potatoes. Many areas of this soil are at a higher elevation than the water supplies, and a few of these soils are used for range. Wheat, alfalfa, and pasture crops are suited to dryland.

This soil is better suited to sprinkler irrigation than to other methods. Leveling for furrows and borders commonly requires deep cuts that expose the infertile subsoil in many places. Thin cuts expose bedrock on the Dodes and Lorella soils. Sprinklers afford the most accurate control of soil moisture for crops and do not require extensive land preparation. Rate of application of water needs to be carefully adjusted to prevent soil loss from erosion. Because some areas are at a higher elevation than the water supplies, pumping water from canals, ditches, or wells is needed to irrigate.

Drainageways between some slopes need to be seeded to grass to prevent the formation of gullies. A tillage pan can form in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent formation of such a pan. Use of grain and other crop residue improves tilth and soil structure. If the soil is irrigated, a cropping system of 5 or 6 years of pasture of alfalfa and 2 years of grain is suitable where cross slope tillage and other practices are used to reduce erosion. Permanent pasture also is well suited to this soil. A suitable cropping system for dryland consists of several years of alfalfa, summer fallow, and wheat. Permanent pasture or a cropping system that uses close growing plants most of the time is well suited to this soil. Using crop residue, farming across the slope, and fall chiseling after harvest decrease runoff and soil loss from erosion and increase moisture available for future crops.

The climax native plant community on this soil is dominated by such tall bunchgrasses as basin wildrye and bluebunch wheatgrass. A wide variety of perennial forbs occur throughout the stand. Desirable shrubs, for example, antelope bitterbrush, big sagebrush, and Klamath plum commonly occur; bitterbrush is the most prominent.

If the range site deteriorates, tall bunchgrasses decrease. Big sagebrush, the least desirable of the native shrubs, increases and strongly dominates the stand. If the site severely deteriorates, the bunchgrasses are nearly eliminated and only weeds and annual grasses remain under the brush. In this condition, western juniper invades from adjacent areas of shallow stony soil, and if there is no periodic fire, juniper dominates the range site in places.

If the range is in poor condition, seedbed preparation and seeding are needed. Intermediate wheatgrass, crested wheatgrass, and alfalfa are suitable for dryland seeding. Plants for dryland seeding should be drought resistant and have deep, penetrating root systems.

Because of low strength and slope, this soil has important limitations for such community uses as homesites, small buildings, and roads. Slope also is a limitation if lagoons are planned for this soil. Moderately slow permeability can cause septic tank absorption fields to function poorly and fail in a few years. Many areas of this soil are used for homesites in suburban and rural areas.

This soil is in capability subclass IIIe.

24E-Harriman-Lorella complex, 5 to 35 percent south slopes. These well drained soils are on escarpments that mostly face south. The Harriman soil formed in lacustrine sediment weathered mainly from diatomite, tuff, and basalt. It mostly occurs in strands and hillocks adjacent to patches of Lorella soil. The Lorella soil formed in residual material weathered mainly from tuff and basalt. It commonly occurs as irregularly shaped patches among large areas of Harriman soil. Elevation ranges from 4,100 to 4,500 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

This complex is about 55 percent Harriman loam, 5 to 35 percent slopes, and about 25 percent Lorella very stony loam, 5 to 35 percent slopes. Included are small areas of Dodes and Calimus soils and spots of Rock outcrop.

Typically, the Harriman soil has a surface layer of very dark brown loam about 18 inches thick. The subsoil extends to a depth of about 48 inches. The upper part, to a depth of about 42 inches, is very dark grayish brown or dark brown clay loam; the lower part, to a depth of 48 inches, is dark brown sandy clay loam. Extremely firm, lacustrine tuff bedrock is at a depth of 48 inches. In many places, the underlying bedrock is diatomite.

Permeability is moderately slow in the Harriman soil. Roots penetrate to a depth of 40 to 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 7 to 12 inches. The water-supplying capacity for natural vegetation is 11 to 13 inches.

Typically, the Lorella soil has a surface layer of very dark grayish brown very stony loam about 5 inches thick. The subsoil extends to a depth of about 19 inches. The upper part, to a depth of about 10 inches, is dark brown, very cobbly clay loam; the lower part, to a depth of about 19 inches, is dark yellowish brown, very cobbly clay. Hard tuffaceous bedrock is at a depth of 19 inches. In places, the underlying bedrock is diatomite.

Permeability is slow in the Lorella soil. Roots commonly penetrate to a depth of 10 to 20 inches. Runoff is rapid, and the hazard of erosion is high. Available water capacity is 1 or 2 inches. The water-supplying capacity for natural vegetation is 5 to 8 inches.

This complex is used mostly for range, irrigated and dryland pasture, and suburban development. Because nearly all areas of this soil are at a higher elevation than the water supplies, pumping water upslope is needed to irrigate. Kentucky bluegrass and alta fescue are well suited to irrigated pasture.

The climax native plant community on the Harriman soil in this complex is dominated by tall bunchgrasses, for example, basin wildrye and bluebunch wheatgrass. Such desirable shrubs as antelope bitterbrush, big sagebrush, and Klamath plum are common. The climax native plant community on the Lorella soil is dominated by western juniper that has about 15 percent canopy cover. Bluebunch wheatgrass, big sagebrush, and bitterbrush dominate the understory.

If the range site deteriorates, bluebunch wheatgrass and bitterbrush decrease and big sagebrush and other less desirable shrubs increase. If the site severely deteriorates and there are no periodic fires, juniper encroaches on the deep Harriman soil and dominates the complex in places.

Seedbed preparation and seeding on deeper soil areas of this complex are needed if the range is in poor condition. Crested wheatgrass, pubescent wheatgrass, and alfalfa are suitable for dryland seeding. Wildlife values, especially food and cover needs for deer winter range, should be considered in planning management alternatives.

Because of excessive slope, low strength, and shallow depth to bedrock, Lorella soil has important limitations for such community uses as homesites, small buildings, roads, and most other development. Basement and foundations may crack because of slippage along bedrock joints and planes. Tendency of the subsoils to shrink and swell limits design of foundations and footings in both Harriman and Lorella soils. Moderately slow permeability and excessive slope may cause septic tank absorption fields in the Harriman soil to function poorly or fail in a few years. Limited soil depth, excessive slope, and moderately slow permeability may cause absorption fields placed in the Lorella soil to fail. Many homesites are on these soils in suburban areas.

This complex is in capability subclass IVe.

25-Henley loamy fine sand. This somewhat poorly drained soil is on low terraces. It formed in loamy, alluvial and lacustrine sediment that has an overwash of loamy fine sand. A hardpan is at a depth of 20 to 40 inches. This soil has sufficient sodium to interfere with the growth of most crop plants. Slopes are 0 to 2 percent, and unleveled areas are uneven or hummocky. Elevation is 4,050 to 4,070 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is dark grayish brown loamy fine sand about 11 inches thick. The subsoil extends to a depth of 36 inches. The upper part, to a depth of about 25 inches, is dark brown loam and fine sandy loam; the lower part, to a depth of about 36 inches, is brown sandy loam. An indurated hardpan is at a depth of 36 inches. The surface layer is strongly alkaline, and the subsoil and hardpan are moderately alkaline to strongly alkaline.

Included with this soil in mapping are about 30 percent areas of soils that are mildly alkaline and moderately alkaline, about 10 percent areas of Fordney and 10 percent of Poe soils that are about 1 acre to 3 acres in size, and a few areas of soils that are predominantly mildly alkaline throughout. The hardpan is weakly cemented in parts of some areas.

Permeability is moderate. Roots mostly penetrate to a depth of 20 to 40 inches. Runoff is very slow, and the hazard of water erosion is slight. There is a moderate hazard of wind erosion in spring when the surface layer dries and windspeed is high. Available water capacity is as low as 2.5 inches where depth to the hardpan is about 20 inches and a considerable amount of salt is present; it is as high as 7.5 inches where depth to the hardpan is nearly 40 inches and the soil has a small amount of salt. A water table that results partly from irrigation is at a depth of about 1.5 to 3.5 feet, and commonly it is below a depth of 2 feet. Seepage from canals and ditches that cross this soil raises the water table considerably.

This soil is used mainly for irrigated crops, for example, alfalfa hay, wheat, oats, barley, pasture, and cereal hay. Oats mainly are grown for cereal hay. Irish potatoes can be grown in drained areas if most of the excess sodium and salt have been leached from the soil. Partially drained and reclaimed areas are used for pasture and barley. Alta fescue is used for pasture.

This soil is better suited to sprinkler irrigation than to other irrigation methods because of the rapid water intake rate. Deep cuts made in leveling for borders and furrows create shallow spots or expose the hardpan in many places. Sprinklers supply moisture adequate for crop needs, do not require extensive land preparation, and are effective in leaching excess sodium and salt below the root zone of crops. Rate of application of water needs to be carefully adjusted to prevent raising the water table. Overirrigation perches a water table above the hardpan and causes crop damage from waterlogging. Lining canals and ditches that cross this soil is effective in controlling the water table. Deep drains are needed in nearly all areas to lower the water table below the root zone of crops.

Leaching with irrigation water over a period of years can reduce excess sodium and salt if the soil has been adequately drained. Remaining spots of alkali and slick or dispersed spots that resist leaching may respond to gypsum or sulfur. Deep ripping to break up the hardpan hastens reduction of sodium and salt content, but it is of doubtful value if the hardpan is too thick to be broken through, or if the soil is too moist to shatter well.

Alta fescue pasture and a cropping system that provides plant cover in spring when the surface layer is subject to blowing are well suited to this soil. Also suited is a long term cropping system that uses more alkali sensitive crops as the excess sodium and salt are removed from the soil by leaching. A cropping system of 5 or 6 years of alfalfa hay, 1 or 2 years of potatoes, and 1 year of grain is suited to drained areas where nearly all of the sodium and salt has been removed. Barley grown for hay is suited to areas that predominantly are strongly alkali if the water table is sufficiently below the root zone of this crop. Use of grain crop residue and conducting tillage and other farming operations at right angles to the prevailing winds reduces wind erosion.

Because of wetness, potential frost action, and the cemented hardpan, this soil has important limitations for such community uses as homesites, small buildings, and roads. Because of the water table and hardpan, excavations mainly cannot be made to a depth of more than 2 or 3 feet. Seepage into ground water is a potential hazard where lagoons and landfills are placed on this soil. Soil depth and wetness can cause septic tank absorption fields to function poorly or fail in a few years. Many homesites are on this soil in rural areas.

This soil is in capability subclass IIIw.

26-Henley loam. This somewhat poorly drained soil is on low terraces. It formed in alluvial lacustrine sediment. A hardpan is at a depth of 20 to 40 inches. This soil has sufficient sodium to interfere with the growth of most crop plants. Slopes are 0 to 2 percent in nearly all places, but in a few small areas slopes are as much as 5 percent. Elevation ranges from 4,050 to 4,150 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is dark grayish brown or very dark grayish brown loam about 11 inches thick. The subsoil is dark brown or brown loam, fine sandy loam, or sandy loam that extends to a depth of about 36 inches. An indurated hardpan is at a depth of 36 inches. The surface layer is strongly alkaline or very strongly alkaline, and the subsoil and hardpan are moderately alkaline to strongly alkaline.

Included with this soil in mapping are about 10 percent areas of Laki soil that are mostly less than 2 acres in size, about 20 percent areas of soils that have a hardpan at a depth of 10 to 20 inches, and a few areas of soils that have been drained and irrigated for many years and which predominantly are mildly alkaline or moderately alkaline. Parts of a few areas have a subsoil of clay loam.

Permeability is moderate. Roots penetrate to a depth of 20 to 40 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is as low as 3 inches where depth to the hardpan is about 20 inches and a considerable amount of salt is present; it is as high as 8.5 inches where depth of the hardpan is nearly 40 inches and the soil has a small amount of salt. A water table is at a depth of 1 foot to 3.5 feet during the period of irrigation. The soil floods occasionally if not protected by dikes or other structures.

This soil is used mainly for irrigated pasture. Where much sodium and salt are present, tall wheatgrass can be grown; if the soil has a moderate content of alkali, alta fescue is a suitable pasture crop; where the soil has been drained and much of the alkali has been removed, alfalfa hay, wheat, oats, barley, and cereal hay are grown. Oats mainly is grown for cereal hay. Barley grown for hay is suited to drained areas that have a high content of alkali. These crops commonly have spotty, uneven growth because of variation in the amount of alkali from place to place in the field. Irish potatoes commonly are not grown. If the soil is drained and totally free of alkali, however, this crop can be grown. A few areas of soil, mainly near the Oregon-California border, were never cultivated and are used for saltgrass pasture.

This soil is suited to sprinkler and border irrigation. Leveling for borders commonly requires only thin cuts; if deeper cuts are made, the hardpan can be exposed. Sprinklers supply soil moisture adequate for crop needs, do not require extensive land preparation, and are suited to the few areas where slopes exceed 2 percent. In addition, they effectively leach sodium and salt below the root zone of crops. Rate of application of water needs to be carefully adjusted to prevent raising of the water table. Overirrigation readily perches a water table above the hardpan and causes crop damage from waterlogging. Slick or dispersed spots have a low water intake rate and require a longer wetting time to be adequately irrigated. Many areas of soil are subirrigated from the water table, but subirrigation probably increases the amount of alkali in the soil. Deep drains are needed in nearly all areas to lower the water table.

Leaching with irrigation water over a period of many years can reduce excess sodium and salt if the soil has been adequately drained, and remaining spots of alkali and slick or dispersed spots that resist leaching may respond to sulfur or gypsum. Deep ripping to break up the hardpan can hasten reduction of sodium and salt content, but it is of doubtful value where the hardpan is too thick to be broken through, or if the soil is too moist to shatter well.

Use of crop residue and the addition of organic material improve structure at the soil surface and increase the rate of water intake, particularly on slick or dispersed spots. Hard crusts on these spots commonly hinder seedling emergence. A long term cropping system that uses more alkali sensitive crops is well suited to this soil as soon as the alkali content is reduced by leaching. In such a cropping system tall wheatgrass and alta fescue pasture could be grown for many years, followed by barley hay, by alfalfa hay, and by wheat and oats. When the soil is free of alkali and where the frost-free season is about 100 days or more, Irish potatoes can be grown.

Because of wetness, potential frost action, and the hazard of flooding, this soil has important limitations for such community uses as homesites and small buildings. Potential frost action and wetness also are limitations for roads. Elevated roadbeds are commonly built on this soil. Wetness and soil depth can cause septic tank absorption fields to fail in a few years. Because of failure or partial failure of such systems, a large sanitary district sewer system has been constructed for suburban areas near Klamath Falls. Contamination of ground water is a potential hazard where lagoons are placed on this soil.

This soil is in capability subclass IVw.

27-Henley-Laki complex. These soils are on low terraces. They formed in alluvial and lacustrine sediment. The Henley soil is somewhat poorly drained, and the Laki soil is moderately well drained. The Henley soil is underlain by a hardpan at a depth of 20 to 40 inches. Both soils have sufficient sodium to interfere with growth of crops. Slopes are 0 to 2 percent. Elevation is about 4,090 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-season season is about 80 to 110 days.

This complex is about 60 percent Henley sandy loam and about 40 percent Laki fine sandy loam.

Typically, the Henley soil has a surface layer of dark grayish brown or very dark grayish brown sandy loam about 11 inches thick. The subsoil is dark brown or brown loam, fine sandy loam, or sandy loam and extends to a depth of 36 inches. An indurated hardpan is at a depth of 36 inches. The surface layer is strongly alkaline, and the subsoil and hardpan are moderately alkaline to strongly alkaline.

Permeability is moderate in the subsoil and very slow in the hardpan in the Henley soil. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is very slow, and the hazard of erosion is slight. There is a hazard of wind erosion in spring when the surface dries and windspeed is high. Available water capacity is as low as 3 inches where depth to the hardpan is 20 inches and considerable amount of salt is present; it is as high as 8.5 inches where depth to the hardpan is nearly 40 inches and the soil has a small amount of salt. A water table is at a depth of 1 foot to 3.5 feet during the period of irrigation.

Typically, the Laki soil has a surface of very dark brown and very dark grayish brown fine sandy loam about 19 inches thick. The subsoil is dark grayish brown loam that extends to a depth of about 32 inches. The substratum is dark brown and dark grayish brown loam to a depth of 60 inches or more. The surface layer is moderately alkaline, and the subsoil and substratum are strongly alkaline.

Permeability is moderate in the Laki soil. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of water erosion is slight. There is a hazard of wind erosion in spring when the surface layer dries and windspeed is high. Available water capacity is about 12 to 18 inches, and it is highest where the soil has the most ash and diatomaceous material. A water table is at a depth of about 2 to 5 feet during the period of irrigation.

This complex is used mainly for irrigated crops, for example, alfalfa hay, oats, barley, wheat, pasture, and cereal hay. Alta fescue mostly is grown for pasture. Oats commonly are grown for cereal hay. Barley is well suited to nearly all drained areas of soils. Alfalfa, wheat, and oats are grown in areas that have been irrigated for many years and largely are free of alkali. Crops commonly have a spotty, uneven growth because the content of alkali varies from place to place in the field. Irish potatoes are grown in a few drained areas that are free of alkali.

This complex is better suited to sprinkler irrigation than to other irrigation methods because of the high water intake rate. A large quantity of water needs to be applied to irrigate the lower ends of borders and furrows. Excess water that is not used by crops raises the water table. Cuts of more than 2 feet in leveling for borders and furrows create shallow spots or expose the hardpan on the Henley soil. Rate of application of water needs to be carefully adjusted to prevent raising the water table. Overirrigation readily perches a water table above the hardpan of the Henley soil and results in crop damage from waterlogging. Slick or dispersed spots need a longer wetting time to be adequately irrigated. Deep drains are needed in nearly all areas to lower the water table below the root zone of crops and to permit leaching of alkali. Lining canals and ditches that cross this complex help lower the water table.

Leaching with irrigation water over a period of years can reduce excess sodium and salt if the soils have been adequately drained. Remaining spots of alkali and slick or dispersed spots that resist leaching may respond to sulfur and gypsum. Deep ripping to break up the hardpan in the Henley soil can hasten reduction of alkali content, but it is of doubtful value where the hardpan is too thick to be broken through, or if the soil is too moist to shatter well. Use of crop residue and the addition of organic material improve soil structure and increase the rate of water intake on slick or dispersed spots. Hard crusts on these spots hinder seedling emergence.

A long term cropping system that uses more alkali sensitive crops is well suited to this complex as soon as alkali content is reduced by leaching. After sufficient reduction of alkali, the cropping system can include alta fescue pasture for many years followed by barley, by alfalfa hay, and by wheat and oats. When the soils are completely reclaimed, and where the frost-free season is about 100 days or more, Irish potatoes can be grown.

Because of wetness, potential frost action, and the hazard of flooding, these soils have important limitations for such community uses as homesites and small buildings. Potential frost action and wetness also are limitations for roads. Elevated roadbeds are commonly constructed on this complex. Wetness in both soils and soil depth in the Henley soil can cause septic tank absorption fields to function poorly and fail in a few years. Because of failure or partial failure of such systems on this complex, a large sanitary district sewer system has been constructed for suburban areas near Klamath Falls.

This complex is in capability subclass IVw.

28-Henley-Laki loams. These soils are on low terraces. They formed in mixed alluvial and lacustrine sediment. The Henley soil is somewhat poorly drained and is underlain by a hardpan at a depth of 20 to 40 inches. The Laki soil is moderately well drained and is calcareous. Both soils have sufficient sodium to interfere with the growth of crops. Slopes are 0 to 2 percent. Elevation ranges from 4,050 to 4,150 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature to 46 to 49 degrees F, and the frost-free season is about 80 to 110 days.

This complex is about 60 percent Henley loam and about 40 percent Laki loam. The proportion of Henley soil is about 85 percent in a few areas, and about 50 percent in a few other areas.

Typically, the Henley soil has a surface layer of dark grayish brown or very dark grayish brown loam about 11 inches thick. The subsoil is dark brown or brown loam, fine sandy loam, or sandy loam that extends to a depth of about 36 inches. An indurated hardpan is at a depth of 36 inches. The surface layer is strongly alkaline or very strongly alkaline, and the subsoil and hardpan are moderately alkaline or strongly alkaline.

Permeability is moderate in the subsoil and very slow in the hardpan in the Henley soil. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is as low as 3 inches where depth to hardpan is 20 inches and considerable salt is present; it is as high as 8.5 inches where depth to hardpan is nearly 40 inches and the soil has little salt. The water table is at a depth of 1 foot to 3.5 feet during the period of irrigation.

Typically, the Laki soil has a surface layer of very dark brown and very dark grayish brown loam about 19 inches thick. The subsoil is dark grayish brown loam that extends to a depth of 32 inches. The substratum is dark brown and dark grayish brown loam to a depth of 60 inches or more. The surface layer is moderately alkaline, and the subsoil and substratum are strongly alkaline.

Permeability is moderate in the Laki soil. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of water erosion is slight. Available water capacity is 12 to 18 inches and is highest where the soil has the greatest amount of ash and diatomaceous material. A water table is at a depth of 2 to 5 feet during the period of irrigation.

This complex is subject to occasional flooding if not protected by dikes or other structures.

This complex is used for irrigated crops, for example, pasture, alfalfa hay, barley, oats, wheat, and cereal hay. Most areas are used for pasture. Tall wheatgrass can be grown for pasture where the alkali content is very high. Alta fescue can be grown where alkali content is moderate. Oats mainly are grown for cereal hay in partially reclaimed areas. Alfalfa, wheat, and oats grow in soils that have been drained and irrigated for many years and are largely free of alkali. Barley grown for hay is suited to nearly all drained areas of this complex. Crops commonly have a spotty, uneven growth because the alkali content varies from place to place in the field. Few areas are sufficiently free of alkali to be suitable for Irish potatoes.

This complex is suited to sprinkler, furrow, and border irrigation. Leveling for furrows and borders commonly requires only thin cuts; if deeper cuts are made, the hardpan in the Henley soil can be exposed. Sprinklers supply soil moisture adequate for crop needs, do not require extensive land preparation, and are effective in leaching sodium and salt below the root zone of crops. Rate of application of water needs to be carefully adjusted to prevent raising the water table. Overirrigation readily perches a water table above the hardpan in the Henley soil and causes crop damage from waterlogging. Slick or dispersed spots have a low water intake rate and require a longer wetting time to be adequately irrigated. Many areas are subirrigated from the water table, but subirrigation probably increases sodium and salt accumulation in the soil. Deep drains are needed in nearly all areas to lower the water table and to reduce content of alkali.

Leaching with irrigation water over a period of many years can reduce excess sodium and salt if the soils have been adequately drained. Remaining spots of alkali and slick or dispersed spots that resist leaching may respond to gypsum or sulfur. Deep ripping to break up the hardpan can hasten reduction of alkali content, but ripping is of doubtful value if the hardpan is too thick to be broken through, or if the soil is too moist to shatter well. Use of residue from crops and addition of available organic material improve structure at the soil surface and increase water intake, particularly on slick or dispersed spots. Hard crusts on these spots commonly hinder seedling emergence. A long term cropping system that uses more alkali sensitive crops is well suited to this complex as soon as the alkali content is reduced by leaching. In such a system tall wheatgrass or alta fescue pasture could be grown for many years, followed by barley, by alfalfa hay, and by wheat and oats after sufficient reduction of alkali. When the soils are completely free of alkali, Irish potatoes can be grown if the frost-free season is about 100 days or more.

Because of wetness, potential frost action, and hazard of flooding, these soils have important limitations for such community uses as homesites and small buildings. The potential frost action and wetness are limitations for roads. Elevated roadbeds commonly are constructed on this complex. Wetness in both soils of the complex and limited soil depth in the Henley soil can cause septic tank absorption fields to function poorly and fail in a few years. Because such systems have failed over large areas of this complex, a large sanitary district and sewer system for suburban areas near Klamath Falls has been constructed.

This complex is in capability subclass IVw.

29-Henley Variant loam. This somewhat poorly drained soil is on low terraces. It formed in mixed alluvial and lacustrine sediment. An indurated hardpan is at a depth of 10 to 20 inches. This soil has sufficient sodium to interfere with the growth of most crop plants. Slopes are 0 to 2 percent. Elevation ranges from 4,050 to 4,150 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is very dark grayish brown loam about 6 inches thick. The subsoil is very dark grayish brown loam that extends to a depth of about 16 inches. An indurated hardpan is at a depth of 16 inches. Below the hardpan is brown loam to a depth of 60 inches or more. The surface layer is strongly alkaline or very strongly alkaline; the subsoil, the hardpan, and the lower part of the substratum are moderately alkaline or strongly alkaline.

Included with this soil in mapping are about 15 percent areas of Henley soil. Also included is a small area of soils in the southern end of Langell Valley where the hardpan predominantly extends from a depth of 4 to more than 60 inches.

Permeability is moderate. Roots mostly penetrate to a depth of 10 to 20 inches. Runoff is very slow, and the hazard of water erosion is slight. Available water capacity is about 1.5 to 4 inches. A water table commonly is at a depth of 1 foot to 3 feet and is perched above the hardpan following irrigation. The soil is subject to occasional flooding if not protected by dikes or other structures.

This soil is used mainly for irrigated pasture crops, for example, fescue and tall wheatgrass. Crops may have uneven growth or a spotty appearance because the content of alkali varies from place to place in the field. Only inland saltgrass grows in a few areas.

This soil is better suited to sprinkler irrigation than to other irrigation systems because even thin cuts made in leveling for borders tend to expose the hardpan in many places. Rate of application of water needs to be carefully adjusted to prevent raising the water table. Overirrigation perches a water table above the hardpan and results in waterlogging and pasture damage. Slick or dispersed spots have a low water intake rate and need a longer wetting period to be adequately irrigated. Deep drains are needed in nearly all areas to lower the water table.

Leaching with irrigation water reduces alkali content if the hardpan can be broken up and the soil drained. Remaining spots of alkali and slick or dispersed spots that resist leaching may respond to sulfur or gypsum. Ripping the hardpan is of doubtful value where it is too thick to be broken through or where the soil is too moist to shatter well. Use of organic material improves structure at the soil surface and increases the rate of water intake, particularly on slick or dispersed spots. The hard crusts that form in these spots tend to hinder or prevent seedling emergence and make it difficult to establish pastures.

Because of the hazard of flooding, wetness, and the cemented hardpan, this soil has important limitations for such community uses as homesites, small buildings, and roads. Roadbeds need to be elevated where they cross this soil. Shallow soil depth and wetness can cause septic tank absorption fields to function poorly and fail. This soil is not used for homesites.

This soil is in capability subclass IVw.

30-Histosols, ponded. This map unit consists of ponded, marshy areas (fig. 5) on the fringes of Upper Klamath and Agency Lakes. The largest areas, along the west side of these lakes, make up the Upper Klamath National Wildlife Refuge. A smaller area, along the east side of Wood River north of Agency Lake, is named Wood River Marsh. The floor of the marsh mainly consists of stratified layers of peat and muck and thin layers of diatomaceous silt. Elevation of the water surface is about 4,140 feet. The average annual precipitation is about 18 to 25 inches, the average annual air temperature is 42 to 44 degrees, and the frost-free season is about 120 to 130 days.

Depth to water above the floor of the marsh ranges to as much as 3 feet. Typically, about 30 percent of the area consists of clumps of aquatic plants and small hillocks that protrude 1 foot to 3 feet above the surface of the water. At high water level these hillocks may be submerged and only the taller water plants, for example, bulrush and cattails, protrude above water. Wocus lily is in some of the deeper water areas.

Included with this soil in mapping are numerous submerged stream channels where the water depth is considerably more than 3 feet. Also included are areas where aquatic plants form a nearly continuous cover on the marsh. There are also intermittent, large patches of open water.

Large areas adjacent to this unit north of Agency Lake have been reclaimed by diking and draining. These reclaimed areas are Lather muck, and they mainly are used for irrigated pasture, cereal hay, and wildlife habitat.

This unit is used for wildlife habitat, waterfowl refuge, and recreation. It is in the path of one of the major migratory waterfowl flyways in the Northwest, and it provides feed and cover for ducks and geese in spring and fall.

This soil is in capability subclass VIIIw.

31-Hosley loam. This somewhat poorly drained soil is on low terraces. It formed in alluvial and lacustrine sediment. This soil has sufficient sodium to interfere with the growth of most crop plants. Slopes are 0 to 1 percent. Elevation ranges from 4,050 to 4,200 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is very dark grayish brown loam about 12 inches thick. The subsoil is dark brown clay loam that extends to a depth of about 26 inches. The upper part of the substratum, to a depth of 42 inches, is a dark brown indurated hardpan. The lower part, below the hardpan, is dark brown loam that extends to a depth of 60 inches or more. The surface layer is moderately alkaline or strongly alkaline, and the subsoil is strongly alkaline or very strongly alkaline.

Included with this soil in mapping are about 10 percent areas of Laki and Henley soils that are mainly less than 1 acre in size. Also included are a few areas of soils where the hardpan dominantly is at a depth of 10 to 20 inches.

Permeability is moderately slow. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is very slow, and the hazard of water erosion is slight. Available water capacity is 4 to 9 inches. A water table commonly is at a depth of 1 foot to 3.5 feet. The soil is subject to occasional flooding if not protected by dikes or other structures.

This soil is used mainly for irrigated pasture. Tall wheatgrass can be grown for pasture where the alkali content is very high. Alta fescue can be grown where alkali content is moderate. Barley can be grown for hay if adequate drainage is provided, even though a considerable amount of alkali is present. Pasture crops commonly have spotty uneven growth because the content of alkali varies from place to place in the field. In a few areas, saltgrass pasture mainly is grown. Most areas of this soil have not been drained and are not sufficiently free of alkali to be used for other crops.

This soil is suited to sprinkler and border irrigation. Leveling for borders commonly requires only thin cuts; if deeper cuts are made, the hardpan can be exposed in many places. Sprinklers supply soil moisture adequate for crop needs, do not require extensive land preparation, and are effective in leaching sodium and salt below the root zone of crops if the soil has been adequately drained. Rate of application of water needs to be carefully adjusted to prevent raising the water table. Overirrigation perches a water table above the hardpan and results in waterlogging and pasture damage. Slick or dispersed spots need a longer wetting time to be adequately irrigated. Many areas are subirrigated from the water table, but subirrigation probably increases the amount of sodium and salt that accumulate in the soil. Deep drains are needed for nearly all areas to lower the water table.

This soil is difficult to reclaim, and no areas have been fully reclaimed. Leaching with irrigation water over a period of many years can reduce excess sodium and salt if the soil has been adequately drained. Deep ripping to break up the hardpan can hasten reclamation if the hardpan is dry and is not too thick to be broken through. If the hardpan is moist, it does not shatter well. Spots of alkali, including slick and dispersed spots that resist leaching, may respond to gypsum or sulfur. Application of organic material can improve soil structure and increase the rate of water intake on these spots. Hard crusts tend to form on these spots that can hinder or prevent the emergence of grass seedlings.

A long term cropping system that uses more alkali sensitive crops is suited to this soil as soon as the sodium and salt are reduced by leaching. In such a system tall wheatgrass or alta fescue pasture could be grown for many years, followed by barley hay, by alfalfa hay, and by wheat and oats. Potatoes would not be suited to this soil even if it were free of alkali because of the comparatively high content of clay in the subsoil.

Because of wetness and high potential frost action, this soil has important limitations for such community uses as homesites, small buildings, and roads. Flooding also is a limitation for homesites and buildings in areas that are not protected by dikes or other structures. Low strength and potential frost action are limitations if the soil material is used for roadfill. Excavations to a depth of more than 2 feet likely will encounter the hardpan and water table. Roadbeds need to be elevated where they cross this soil. Moderately slow permeability, wetness, and soil depth can cause septic tank absorption fields to function poorly or fail in a few years. Because of failure or partial failure of absorption fields on this soil, a sanitary district sewer system has been constructed for suburban areas near Klamath Falls.

This soil is in capability subclass IVw.

32-Kirk loam, alkali. This poorly drained soil is on flood plains. It formed in alluvium of ash and cinders from dacitic pumic flows. This soil has sufficient sodium to interfere with the growth of most crop plants. Slopes are 0 to 1 percent. The surface is uneven or corrugated in many places. Elevation is about 4,152 feet. The average annual precipitation is 16 to 24 inches, the average annual air temperature is 42 to 44 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 12 inches thick. The upper part is black loam about 3 inches thick that is covered with patches of thin brownish salt crusts. The lower part is black or very dark brown loam about 9 inches thick. The upper part of the underlying material is very dark grayish brown, mottled, gravelly coarse sandy loam that extends to a depth of about 20 inches; the lower part is pale brown, very gravelly coarse sand to a depth of 60 inches or more. The surface layer is strongly alkaline and is calcareous.

Included with this soil in mapping are about 15 percent areas of Chock soil; about 30 percent areas of a soil where the surface layer is mildly alkaline or moderately alkaline; and about 10 percent areas of a soil that are calcareous and strongly alkaline to a depth of more than 20 inches.

Permeability is rapid. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight except in periods of flooding when channeling occurs. Available water capacity is 14 to 17 inches. A water table commonly is at a depth of 1 foot to 3 feet. The soil is subject to frequent flooding in spring if not protected by dikes.

This soil is used mainly for pasture and wildlife habitat. Inland saltgrass, Baltic rush, Kentucky bluegrass, clover, and sedges grow in this soil.

This soil is better suited to sprinkler irrigation than to other irrigation methods. At present the soil is irrigated by uncontrolled flooding from ditches, or it is subirrigated from the water table. Leveling the uneven surface for borders can expose the infertile, very gravelly and sandy underlying layers in many places. This soil can be reclaimed over a period of a few years by leaching with irrigation water if the water table is sufficiently lowered with drains. Remaining slick spots and alkali spots can be treated with sulfur or gypsum. Subirrigation probably increases the content of alkali in the surface layer. With good water control measures, complete renovation including seedbed preparation and seeding can improve pastures. Tall fescue, meadow foxtail, and timothy are suitable for seeding. Erosion and cutting of channelbanks during high water periods occur along Wood River on this soil. Protection of channelbanks can help reduce cutting and soil loss.

Because of wetness and potential frost action, this soil has important limitations for such community uses as homesites and small buildings. Flooding also is a limitation for these uses in areas that are not adequately protected by dikes. Elevated roadbeds are built on roads that cross this soil. Roadside ditches commonly have flowing water. Ashy and cindery materials have comparatively little weight and may be unstable when used for dikes and embankments, and only these materials are available for use in such structures. Seepage, piping, and difficulty in packing are severe limitations if the soil materials are used for dikes and other embankments. Wetness can cause septic tank absorption fields to function poorly or possibly fail. Seepage and contamination of ground water also are hazards in the operation of septic tank absorption systems or lagoons. A few rural homesites are on this soil.

This soil is in capability subclass Vw.

33-Kirk-Chock association. These poorly drained soils are on flood plains. They formed in alluvial deposits of ash and cinders from dacitic pumice flows. Slopes are 0 to 1 percent. The surface mostly is uneven and hummocky. Elevation ranges from 4,150 to 4,280 feet. The average annual precipitation is 16 to 25 inches, the average annual air temperature is 42 to 44 degrees F, and the frost-free season is 10 to 50 days.

This association is about 70 percent Kirk loam and about 20 percent Chock loam. Both soils are on flood plains in about the same landscape position. Proportions of the Kirk and Chock soils vary somewhat from place to place within the mapped area. The association also includes areas of black and very dark gray silt overlying a very gravelly sandy soil in potholes and narrow swales and some long narrow stringers of a very deep, excessively drained, very gravelly sandy soil.

Typically, the Kirk soil has a surface layer about 9 inches thick. The upper part is very dark gray loamy material about 1 1/2 inches thick that is mixed with roots; the lower part is black and very dark brown loam about 7 1 /2 inches thick. The underlying material is mottled, very dark gray, very gravelly loamy sand to a depth of 60 inches or more.

Permeability is rapid in the Kirk soil. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight except during periods of flooding when channeling occurs. Available water capacity is 14 to 17 inches. A water table commonly is at a depth of 1 foot to 2 feet. The soil is subject to frequent flooding in spring if not protected by dikes.

Typically, the Chock soil has a surface layer about 17 inches thick. The upper part is black loam about 7 inches thick; the lower part is very dark gray, mottled loam about 10 inches thick. The underlying material is dark gray, mottled loam to a depth of 60 inches or more.

Permeability is moderate in the Chock soil. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight except during periods of flooding when channeling occurs. Available water capacity is about 13 to 19 inches. A water table is at a depth of about 1 foot to 2.5 feet. This soil is subject to frequent flooding in spring if not protected by dikes.

This association is used mainly for irrigated pasture (fig. 6) and wildlife habitat. Kentucky bluegrass and alsike clover are the principal pasture plants. Because of the short growing season, nearly all crops except pasture are limited in this association. Most of the cattle that graze these pastures are shipped from California by truck in early spring and are shipped back to California feedlots in early fall.

These soils are better suited to sprinkler irrigation than to other irrigation methods. At present, soils are both surface irrigated and subirrigated. Leveling the uneven surface for borders commonly exposes the very gravelly and sandy underlying layers of the Kirk soil and the infertile substratum of the Chock soil in many places. Only a few areas have been leveled for borders. Many pastures are irrigated from contour ditches and by uncontrolled flooding. Others are subirrigated by the water table which can be raised by running water in ditches that cut into the substratum of the Kirk soil. Subirrigation probably increases the content of sodium and salt in the upper part of the soils. The surface layer of these soils is moderately alkaline in many places.

Erosion and cutting of streambanks during high water periods occur along Wood River and some of the streams that cross this soil. Protection of streambanks and, in places, channel straightening can help reduce streambank cutting.

The climax native vegetation on these soils is a wet meadow plant community dominated by tufted hairgrass. Northern mannagrass, reedgrass, and Nebraska sedge grow in very wet spots. Clover and other desirable forbs occur throughout the stand.

If the range site deteriorates, tufted hairgrass decreases and sedges, rushes, and such sod-forming grasses as Kentucky bluegrass increase. If the site severely deteriorates, less desirable (orbs increase and become more abundant. In this condition, the sod cover is broken in places and erosion channels are formed.

If water control measures are good and if the range site is in poor condition, complete meadow renovation including seedbed preparation and seeding is a practical consideration. Reed canarygrass, meadow foxtail, and tall fescue are suitable for dryland seeding. Plants selected for seeding should tolerate wet, poorly drained soils and be suited to hay or pasture production.

Because of wetness and potential frost action, these soils have important limitations for such community uses as homesites and small buildings. Flooding also is a limitation for these uses in areas that are not adequately protected by dikes. Elevated roadbeds are built in all areas because of wetness and flooding. Roadside ditches commonly have flowing water. The ashy and cindery materials have comparatively little weight and are unstable when used for dikes and embankments. In addition, seepage, piping, and difficulty in packing are severe limitations when these materials are used. Only these materials, however, are available for use in such structures. Wetness can cause septic tank absorption fields to function poorly or fail. Seepage and contamination of ground water also are hazards in the operation of septic tank absorption systems and lagoons.

This association is in capability subclass Vw.

34-Klamath-Ontko-Dilman association. These poorly drained, nearly level soils are on flood plains (fig. 7) and drained embayments along the southern edge of Upper Klamath Lake. They formed in alluvium that has varying amounts of ash. The surface commonly is channeled or corrugated in areas that were not leveled for irrigation. Elevation ranges from about 4,140 to 4,400 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 42 to 45 degrees F, and the frost-free season is 50 to 70 days.

This association is about 55 percent Klamath soil, 30 percent Ontko soil, and 15 percent Dilman soil. The proportions of soils vary somewhat from place to place in this association. In some mapped areas west of Sprague River, the Ontko soil is dominant. The areas on Knott Tableland dominantly are Ontko and Dilman soils. Generally, the Klamath soil is adjacent to streams or in the central part of the flood plain. The Ontko soil is adjacent to the Klamath soil and is between the Klamath and Dilman soils. The Dilman soil is at the outer edges of the flood plain.

Typically, the Klamath soil has a surface layer of very dark gray and black silty clay about 11 inches thick. The subsoil is black silty clay that extends to a depth of about 28 inches. The substratum is mottled, dark gray, very dark gray, and dark grayish brown silty clay and silty clay loam to a depth of 60 inches.

Permeability is slow in the Klamath soil. A water table commonly is at a depth of 0 to 3 feet in spring.

Typically, the Ontko soil has a surface layer of black silty clay loam about 7 inches thick. The subsoil is dark gray clay loam that extends to a depth of about 13 inches. The upper part of the substratum is dark grayish brown or very dark grayish brown coarse sandy loam or loamy coarse sand to a depth of about 28 inches; the lower part is dark grayish brown clay loam to a depth of 60 inches or more.

Permeability is slow in the Ontko soil. A water table commonly is at a depth of 0 to 4 feet in spring.

Typically, the Dilman soil has a surface layer about 13 inches thick. The upper part is black silty clay loam about 3 inches thick, and the lower part is black silty clay about 11 inches thick. The subsoil is very dark gray clay loam and sandy clay loam that extends to a depth of about 28 inches. The substratum is mottled, very dark grayish brown, grayish brown, dark brown, or light gray coarse sand or clay loam to a depth of 60 inches or more. The upper part of the substratum is dominantly pumiceous ash.

Permeability is slow in the Dilman soil. A water table is at a depth of 0 to 3 feet in spring.

Roots commonly penetrate to a depth of more than 60 inches in all soils in this association. The surface layer in these soils has a high content of organic matter. Runoff is very slow, and the hazard of erosion is slight except during periods of flooding when channeling occurs. Available water capacity is about 11 to 16 inches. These soils are subject to frequent flooding in spring if not protected by dikes.

Included with this association in mapping are about 5 percent areas of soils that are strongly alkaline or very strongly alkaline. Also included are soils that have surface layer of loam or sandy loam and soils that have a hardpan at a depth of 16 to 20 inches.

This association is used mainly for irrigated and native hay and pasture (fig. 8). A few areas that are partly drained and protected by dikes are used for cereal hay. Reed canarygrass is grown in some areas. Alfalfa hay is suited to areas where the soils are adequately drained and protected from flooding.

These soils are suited to sprinkler and border irrigation. Undrained areas mostly are subirrigated by the water table in spring. Because of the channeled and corrugated surface of these soils, leveling for borders requires deep cuts. These cuts expose the infertile underlying layers in many places, particularly on the Ontko and Dilman soils. Deep drains are needed to lower the water table. Outlets for drains commonly are not available, and pumping may be needed for drainage. Dikes built along streams protect the soils from flooding. Soils need to be tilled within a narrow range of moisture content because of the high amount of clay in the surface layer. Spring cultivation can be delayed by wetness.

The climax native vegetation on this association (fig. 8) is a herbaceous plant community dominated by a variety of desirable grasses, for example, Leiberg bluegrass, Kentucky bluegrass, meadow barley, slender wheatgrass, and redtop. A variety of perennial forbs grow throughout the stand. Tufted hairgrass occurs in wet areas on the Klamath soil.

If the range site deteriorates, the most desirable grasses decrease and such sod formers as sedge, redtop, and Kentucky bluegrass increase. If the site further deteriorates, forbs increase in abundance and such woody plants as green rabbitbrush and silver sagebrush invade. In this condition, much ground is left bare and is exposed to erosion.

If water control measures are adequate, complete renovation, including seedbed preparation and seeding, is practical where the range site is in poor condition. Alta fescue, meadow foxtail, and timothy are suitable for dryland seeding. Plants selected for seeding need to be tolerant of poorly drained soils and a periodic high water table.

Because of the hazard of flooding, wetness, and potential frost action, these soils have important limitations for such community uses as homesites, small buildings, and roads. Roadbeds are elevated wherever roads cross this association. Roadside ditches commonly have standing water and aquatic plants in spring. Except for ash layers, soil materials have low strength and are compressible if used for dikes, dams, and other embankments. Ash layers have comparatively little weight and tend to be unstable when used in these structures. Seepage and piping also are limitations if ashy materials are used in embankments that impound water. Wetness, slow permeability, and flooding can cause septic tank absorption fields to function poorly and fail. No dwellings and only a few other structures have been built on this association.

This association is in capability subclass IVw.

35-Klamath Variant clay loam. This poorly drained, nearly level soil is on flood plains. It formed in alluvium that has 10 to 25 percent ash in the upper part. The soil has sufficient sodium to interfere with the growth of most crop plants. The surface commonly is uneven or channeled in areas that have not been leveled for irrigation. Elevation is 4,280 to 4,320 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 42 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is black clay loam about 19 inches thick. The subsoil extends to a depth of 43 inches. The upper part is very dark gray silty clay loam to a depth of 31 inches; the lower part is olive brown clay loam to a depth of about 43 inches. The substratum is mottled, light olive brown gravelly clay loam to a depth of 60 inches or more. The surface layer is strongly alkaline or moderately alkaline. The subsoil and substratum are mildly alkaline or neutral.

Included with this soil in mapping are about 30 percent areas of soils that are neutral to moderately alkaline in the surface layer, and a few areas where the soil is as much as 50 percent ash. Also included are areas of soils that have a surface layer of silt loam and silty clay loam.

Permeability is slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 12 to 14 inches. A water table is at a depth of 0 to 3 feet in spring. The soil is subject to common flooding in spring unless protected by dikes.

This soil is used mainly for irrigated pasture. A few areas are used for native meadow hay and pasture. Baltic rush, mat muhly, inland saltgrass, and green rabbitbrush are the main natural vegetation. If drainage is adequate and water management is good, complete renovation that includes seedbed preparation and seeding can improve pastures. If drainage and reduction of alkali content are sufficient, alfalfa and oats or rye can be grown for hay.

This soil is suited to sprinkler and border irrigation. Undrained areas mostly are subirrigated by the water table in spring, and this irrigation method increases the content of alkali in the surface layer. Cuts made in leveling for borders commonly expose the infertile subsoil. Deep drains are needed to lower the water table and permit reduction of alkali by leaching with irrigation water. Because outlets for drains commonly are limited, pumping may be needed for drainage. Dikes constructed along drainageways can protect the soil from flooding.

Leaching with irrigation water over a long period of time can reduce the content of alkali if the water table has been lowered sufficiently by drainage. Remaining spots of alkali and slick spots can be treated with sulfur or gypsum. Hard crusts that form on these spots hinder or prevent seedling emergence. Addition of organic material improves soil structure and softens these crusts. Tillage needs to be done within a narrow range of moisture content because of the high content of clay in the surface layer. Spring cultivation commonly is delayed by wetness.

Because of the hazard of flooding, wetness, and potential frost action, this soil has important limitations for such community uses as homesites, small buildings, and roads. Roadbeds need to be elevated wherever they cross this soil. Roadside ditches commonly have aquatic plants, and many have standing water in spring. The soil material has low strength and is compressible if used for embankments and dikes. Wetness and slow permeability can cause septic tank absorption fields to function poorly or fail. This soil is not used for homesites or other structures.

This soil is in capability subclass IVw.

36-Lakeview silty clay loam. This moderately well drained soil is on flood plains and the lower part of alluvial fans. It formed in mixed alluvium weathered from tuff, basalt, and a small amount of ash. Slopes are 0 to 2 percent. Elevation ranges from about 4,050 to 4,200 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the upper part of the surface layer is black silty clay loam about 14 inches thick, and the lower part is black clay loam about 15 inches thick. The subsoil is dark brown clay loam that extends to a depth of about 42 inches. The substratum is brown silt loam to a depth of 60 inches or more.

Included with this soil in mapping are about 5 percent areas of Malin soil that are strongly alkaline or very strongly alkaline, a few areas of soils where the upper part of the subsoil is clay or silty clay, and an area of soil about 2 miles north of Modoc Point where the substratum is silty clay. Also included are about 10 percent areas of soils that have a surface layer of loam or clay loam.

Permeability is moderately slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is about 10 to 12 inches. A water table is at a depth of 2.5 to 5 feet. The soil is subject to occasional flooding if not adequately protected by dikes. Content of organic matter is high in the surface layer and the upper part of the subsoil.

This soil is used mainly for irrigated crops, for example, barley, wheat, oats, alfalfa hay, pasture, and cereal hay. Oats commonly are grown for cereal hay. Alta fescue and Kentucky bluegrass are suitable for pasture. Irish potatoes are not grown because of wetness and the high content of clay in the surface layer and in the upper part of the subsoil.

This soil is suited to sprinkler, border, and corrugation irrigation. Furrows are suited but are not used because of the kinds of crops grown. Sprinkler systems need to be carefully designed because of the low water intake rate. Sprinklers can supply the proper amount of moisture for crop growth without raising the water table. Tail water from borders and corrugations can be disposed of in drains to prevent crop damage from submergence. Cuts generally can be made in leveling for borders or corrugations without exposing the infertile subsoil or underlying layers. Deep drains are needed to lower the water table; however, drainage outlets are limited, and pumping may be needed for drainage. Moderately slow permeability is an added problem in drainage. Dikes commonly are built along streams to protect this soil from flooding.

Spots of Malin soil can be treated with gypsum or sulfur to hasten reduction of alkali content. Hard crusts that hinder or prevent seedling emergence commonly form on these spots. Addition of organic material improves soil structure and softens these crusts. Tillage is difficult on this soil unless it is done within a narrow range of moisture content. Cultivation and planting can be delayed in spring because of wetness.

Permanent pasture is well suited to this soil. If the soil is drained, a cropping system of 5 or 6 years of alfalfa hay or pasture and 1 or 2 years of grain or cereal hay also is suited.

Because of the hazard of flooding, wetness, and potential frost action, this soil has important limitations for such community uses as homesites, small buildings, and roads. Roadbeds need to be elevated where roads cross this soil. Roadside ditches commonly have aquatic plants and may have standing water during the irrigation period. Soil materials have low strength and are compressible and hard to pack if used for embankments. Wetness and moderately slow permeability can cause septic tank absorption fields installed in this soil to function poorly or fail in a few years. This soil is not used for homesites or other structures.

This soil is in capability subclass IIw.

37-Laki fine sandy loam. This moderately well drained calcareous soil is on low terraces. It formed in alluvial and lacustrine sediment weathered from basalt, diatomite, tuff, and ash. Slopes are 0 to 2 percent. Elevation ranges from 4,050 to 4,170 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is very dark brown fine sandy loam about 19 inches thick. The subsoil is dark grayish brown loam to a depth of 32 inches. The substratum is dark brown and dark grayish brown loam to a depth of 60 inches or more. The surface layer is moderately alkaline. The soil ranges from moderately alkaline to strongly alkaline.

Included with this soil in mapping are about 20 percent areas of soils that have a surface layer of loamy fine sand and about 5 percent areas of soils that have a surface layer of loam. Also included are areas of Henley, Poe, and Fordney soils, each of which makes up about 5 percent of the map unit.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of water erosion is slight. There is a hazard of wind erosion in spring when the surface layer dries and windspeed is high. Available water capacity is 11 to 18 inches. A water table is at a depth of 3 to 5 feet during the period of irrigation; it may be higher in overirrigated areas. The soil does not generally flood, but rare flooding can occur if the soil is not protected by dikes or other structures.

This soil is used for irrigated crops, for example, alfalfa hay, Irish potatoes, barley, wheat, oats, cereal hay, and pasture. Crops may have spotty, uneven growth because of variation in the amount of alkali from place to place in the field. Potatoes are grown only on areas that are free of alkali. Oats commonly are grown for cereal hay. Kentucky bluegrass is suited for pasture in drained and reclaimed areas. Alta fescue is suitable for pasture if the soil has considerable alkali content.

This soil is suited to sprinkler, border, and furrow irrigation. Sprinklers are better suited than other irrigation methods because of the high water intake rate. A large amount of water generally needs to be applied to reach the lower end of borders and furrows. Excess water raises the water table. Comparatively deep cuts can be made in leveling this soil without exposing layers of contrasting texture; such cuts, however, expose the strongly alkaline subsoil and underlying layers. Rate of application of water needs to be carefully adjusted with sprinklers to supply proper moisture to crops without raising the water table. Overirrigation can leach soluble plant nutrients, including nitrogen, below the root zone of crops. Deep drains are needed to lower the water table.

Leaching with irrigation water over a period of years reduces excess sodium and salt if the water table has been lowered sufficiently by drainage. Alkali and dispersed spots that resist leaching can be treated with gypsum or sulfur. Hard crusts that hinder or prevent seedling emergence commonly form on these spots. Addition of available organic material softens these crusts and improves structure in the surface layer.

Use of grain and hay crop residue where feasible and conducting farming and tillage operations at right angles to prevailing winds can reduce wind erosion.

Suitable crops and cropping systems vary, depending on the amount of alkali in the soil and depth to the water table. Alta fescue is used for pasture crops in wet areas that have considerable alkali content. In drained areas that are partially free of alkali, a cropping system of 5 or 6 years of alfalfa hay and 1 year of barley can be used. A cropping system of 5 or 6 years of alfalfa hay, 2 years of potatoes, and 1 year of grain or cereal hay is suitable for drained and fully reclaimed areas.

Wetness is the main limitation for such community uses as homesites and small buildings. Basements of dwellings may have a continuing problem of wetness. The possibility of flooding, although remote, is also a limitation for homesites and small buildings. Excavations to a depth of more than 3 feet can encounter a water table. Wetness can cause septic tank absorption fields to function poorly or fail. Seepage and contamination of ground water can occur if lagoons are placed on this soil. The soil material has low strength if used for roads, roadfill, and embankments. Some areas of this soil are used for rural homesites.

This soil is in capability subclass IIIs.

38-Laki loam. This moderately well drained calcareous soil is on low terraces. It formed in very deep alluvial and lacustrine sediment weathered from basalt, diatomite, tuff, and ash. Slopes are 0 to 2 percent. Elevation ranges from 4,050 to 4,200 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is very dark brown loam about 19 inches thick. The subsoil is dark grayish brown loam that extends to a depth of about 32 inches. The substratum is dark brown and dark grayish brown loam to a depth of 60 inches or more. The surface layer is moderately alkaline. The soil ranges from moderately alkaline to strongly alkaline throughout.

Included with this soil in mapping are about 10 percent areas of Henley soil that are mainly less than 1 acre in size, about 5 percent areas of Hosley soil, and a few small areas of soils that mainly have a clay loam and silty clay loam subsoil. As much as 20 percent of many areas of included soils have a hardpan at a depth of 40 to 60 inches.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of water erosion is slight. Available water capacity is 11 to 18 inches. A water table commonly is at a depth of 3 to 5 feet during the period of irrigation; it may be higher in overirrigated areas. The soil is subject to occasional flooding if not protected by dikes or other structures.

This soil is used for irrigated crops, for example, alfalfa hay, Irish potatoes, barley, wheat, oats, cereal hay, and pasture. Crops commonly have spotty, uneven growth because of variation in the amount of alkali from place to place in the field. Potatoes are grown only in a few drained areas that are totally free of alkali. Potatoes grown on this soil are more difficult to clean and are smaller than those grown in sandy soils. Oats commonly are grown for cereal hay. Kentucky bluegrass is suited to drained and reclaimed areas. Alta fescue is used for pasture if the soil has considerable content of alkali.

This soil is suited to sprinkler, border, and furrow irrigation. Sprinklers afford accurate control of soil moisture for crops without raising the water table. Overirrigation can leach soluble plant nutrients, including nitrogen, below the root zone of crops. Comparatively deep cuts can be made in leveling without exposing layers of contrasting texture; such cuts, however, expose a strongly alkaline subsoil and substratum.

Leaching with irrigation water over a period of many years can reduce alkali content if the water table has been lowered sufficiently by drainage. Alkali and dispersed spots that resist leaching can be treated with gypsum or sulfur. Hard crusts commonly form on these spots that hinder or prevent seedling emergence. Application of available organic material can soften these crusts and improve soil structure in the surface layer.

Suitable crops and cropping systems vary, depending on the amount of alkali present in the soil and on depth to the water table. Alta fescue is used for pasture crops in wet areas that have considerable alkali content. In drained and partially reclaimed areas, a cropping system of 5 or 6 years of alfalfa hay and 1 year of barley can be used. A cropping system of 5 or 6 years of alfalfa hay, 2 years of potatoes, and 1 year of grain or cereal hay is suited to drained and fully reclaimed areas.

Because of wetness, this soil has important limitations for such community uses as homesites and small buildings. Basements of dwellings have a continuing problem of wetness. The possibility of flooding, although remote, is also a limitation for homesites and small buildings. Excavations to a depth of more than 3 feet can encounter a water table. Low strength is a limitation where the soil material is used for roads, as roadfill, and for embankments. Wetness can cause septic tank absorption fields to function poorly or fail in a few years. Seepage and contamination of ground water can occur if lagoons are constructed. This soil is used for many homesites in suburban areas.

This soil is in capability subclass IIIs.

39-Laki-Bedner complex. These moderately well drained soils are on low terraces. They formed in alluvial and lacustrine sediment weathered from tuff, basalt, diatomite, and ash. The Laki soil is very deep and has variable amounts of sodium and salt. It is on mounds and ridges about 1 foot to 4 feet above the Bedner soil. The Bedner soil is in narrow swales and has a hardpan at a depth of 20 to 35 inches. Slopes are 0 to 2 percent. The surface is undulating and has many narrow swales, small mounds, and low ridges. Elevation is about 4,195 feet. The average annual precipitation is 12 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

This complex is about 60 percent Laki loam and about 30 percent Bedner clay loam. Small areas of Calder and Scherrard soils each make up about 5 percent of this complex.

Typically, the Laki soil has a surface layer of very dark brown loam about 19 inches thick. The subsoil is dark grayish brown loam that extends to a depth of about 32 inches. The substratum is dark brown and dark grayish brown loam to a depth of 60 inches or more. This soil typically is strongly alkaline in the upper part of the profile or throughout.

Permeability is moderate in the Laki soil. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of water erosion is slight. Available water capacity is 11 to 18 inches. A water table commonly is at a depth of 3 to 5 feet during the irrigation period. This soil is subject to occasional flooding if not protected by dikes or other structures.

Typically, the Bedner soil has a surface layer of black clay loam about 6 inches thick. The subsoil extends to a depth of 21 inches. The upper part, to a depth of 18 inches, is very dark brown clay; the lower part, to a depth of 21 inches, is dark brown clay loam. A weakly cemented, very firm and brittle hardpan is at a depth of 21 inches and extends to a depth of about 31 inches. The substratum below the hardpan is dark brown sandy clay loam to a depth of 60 inches or more.

Permeability is slow in the Bedner soil. Rooting depth commonly is 20 to 35 inches, but some roots penetrate the hardpan. Runoff is very slow, and swales can be flooded by spring runoff. Available water capacity is 3 to 8 inches. A water table commonly is above the hardpan in spring following runoff or irrigation. The surface layer has a high content of organic matter. This soil is frequently flooded.

The soils in this complex are used mainly for pasture and cereal hay. Oats commonly are grown for cereal hay, but barley also is suited. Crops commonly have spotty, uneven growth because of variation in alkali content from place to place in the field. In some areas, wells are used to supply water for irrigation by sprinklers. Such irrigated crops as alfalfa hay and barley are produced for grain, and wheat could be grown if alkali content is sufficiently reduced in the Laki soil. The growing season may be too short for Irish potatoes even though the Laki soil is totally free of alkali. The Bedner soil is too clayey for potatoes. Alta fescue is grown for pasture and is suited to the Laki soil. Inland saltgrass and green rabbitbrush mostly grow on the uncultivated Laki soil, and Baltic rush and silver sagebrush grow on the uncultivated Bedner soil.

This complex is suited to sprinkler, border, and furrow irrigation. Sprinklers are better suited than other irrigation methods because of the surface unevenness. In addition, they afford accurate control of soil moisture for crops without raising the water table. Overirrigation commonly leaches soluble plant nutrients, including nitrogen, below the root zone of crops. Comparatively deep cuts can be made in leveling the Laki soil without exposing layers of contrasting texture. Leveling tends to fill in the swales and cover the Bedner soil to variable depths with strongly alkaline material.

Leaching with irrigation water over a period of years can reduce excess sodium and salt in the Laki soil if the water table has been sufficiently lowered by drainage. Alkali and dispersed spots that resist leaching can be treated with gypsum or sulfur. Hard crusts that commonly form on these spots hinder or prevent seedling emergence. Application of organic material softens these crusts and improves soil structure in the surface layer.

Because of the hazard of flooding and wetness, these soils have important limitations for such community uses as homesites, small buildings, and roads. Basements of dwellings have a continuing problem of wetness. The tendency of the subsoil of the Bedner soil to shrink and swell on drying and wetting is a limitation if this soil material is used for embankments and roadfill. Low strength also is a limitation where soil materials in this complex are used for roads and embankments. Elevated roadbeds are constructed where roads cross the complex. Soil depth, slow permeability, and flooding can cause septic tank absorption fields placed in the Bedner soil to function poorly or fail in a few years. No dwellings or other structures have been built on this complex.

This complex is in capability subclass IIIs.

40-Laki-Henley loams. The soils in this complex are on low terraces. They formed in alluvial and lacustrine sediment weathered from diatomite, tuff, basalt and ash. The Laki soil is moderately well drained, and the Henley soil is somewhat poorly drained. The Laki soil is very deep and has varying amounts of salt. The Henley soil is underlain by a hardpan at a depth of 20 to 40 inches. Both soils have sufficient sodium to interfere with the growth of crops. Slopes are 0 to 2 percent. Elevation ranges from 4,050 to 4,150 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

This complex is about 60 percent Laki loam and about 40 percent Henley loam. A few mapped areas have some small spots of Hosley soil.

Typically, the Laki soil has a surface layer of very dark brown loam about 19 inches thick. The subsoil is dark grayish brown loam that extends to a depth of about 32 inches. The substratum is dark brown and dark grayish brown loam to a depth of 60 inches or more. The surface and subsurface layers are moderately alkaline. The soil ranges from moderately alkaline to strongly alkaline throughout.

Permeability is moderate in the Laki soil. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 11 to 18 inches. A water table commonly is at a depth of 3 to 5 feet during the period of irrigation and is higher in overirrigated areas.

Typically, the Henley soil has a surface layer about 11 inches thick. The upper part is dark grayish brown loam about 5 inches thick, and the lower part is very dark grayish brown loam about 6 inches thick. The subsoil extends to a depth of 36 inches. The upper part, to a depth of 25 inches, is dark brown loam and fine sandy loam; the lower part, to a depth of 36 inches, is brown sandy loam. An indurated hardpan is at a depth of 36 inches. The surface layer is strongly alkaline or very strongly alkaline, and the subsoil and hardpan are moderately alkaline to strongly alkaline.

Permeability is moderate in the Henley soil. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is very slow, and the hazard of water erosion is slight. Available water capacity is as low as 3 inches where depth to the hardpan is 20 inches; it is as high as 6.5 inches where depth to the hardpan is 40 inches. A water table is at a depth of 1 foot to 3.5 feet during the period of irrigation.

This complex is subject to occasional flooding if not protected by dikes or other structures.

This complex is used for irrigated crops, for example, pasture, alfalfa hay, barley, oats, cereal hay, wheat, and Irish potatoes. Alta fescue can be grown for pasture if the soil has a considerable amount of alkali. Kentucky bluegrass is suited in drained and reclaimed areas. Oats commonly are grown for cereal hay; barley also is suitable. Barley grown for grain is suited if the soil is partially free of alkali. Potatoes are grown only in a few areas that are totally free of alkali. They are more difficult to clean and are smaller than potatoes grown in sandy soils. Crops commonly have a spotty, uneven growth because the content of alkali varies from place to place in the field.

This complex is suited to sprinkler, border, and furrow irrigation. Leveling for borders commonly requires only thin cuts; if deeper cuts are made, the hardpan in the Henley soil can be exposed. Sprinklers supply soil moisture adequate for crop needs, do not require extensive land preparation, and are effective in leaching alkali below the root zone of crops. Rate of application of water needs to be carefully adjusted to prevent raising the water table. Overirrigation perches a water table on top of the hardpan in the Henley soil and causes crop damage from waterlogging. Slick or dispersed spots have a low water intake rate and require a longer wetting time to be adequately irrigated. Many areas are subirrigated from the water table. Subirrigation probably increases the amount of alkali that accumulates in the soil. Deep drains are needed to lower the water table.

Leaching with irrigation water over a period of many years can reduce excess sodium and salt if the soils have been adequately drained. Remaining spots of alkali and slick or dispersed spots that resist leaching may respond to gypsum or sulfur. Deep ripping to break up the hardpan can hasten reduction of sodium and salt content in the Henley soil, but is of doubtful value if the hardpan is too thick to be broken through, or if the soil is too moist to shatter well. Hard crusts that commonly form in the surface layer of alkali or slick spots hinder or prevent seedling emergence. Use of crop residue and the addition of organic material can soften these crusts and increase the rate of water intake.

A long term cropping system that uses more alkali sensitive crops is well suited to this complex as soon as alkali content is reduced by leaching. After sufficient reduction of alkali, the cropping system can include tall wheatgrass or alta fescue pasture for many years, followed by barley hay, by alfalfa hay, and by wheat and oats. When the soils are totally free of alkali, and if the frost-free season is about 100 days or more, Irish potatoes can be grown.

Because of wetness, these soils have important limitations for such community uses as homesites, small buildings, and roads. The possibility of flooding, although remote, is also a limitation for homesites and small buildings. Basements of dwellings have a continuing problem of wetness. Elevated roadbeds are constructed where roads cross this complex. Wetness in both soils of this complex and soil depth in the Henley soil can cause septic tank absorption fields to function poorly and fail in a few years.

These soils are in capability subclass IIIs.

41C-Laki Variant loam, 2 to 20 percent slopes. This well drained soil is on beach ridges. It formed in calcareous beach deposits that have a small amount of ash and have been reworked by wind in the upper part. The soil has sufficient sodium to interfere with the growth of most crop plants. Elevation is 4,080 to 4,120 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is dark brown loam about 5 inches thick. The upper part of the substratum is dark brown, brown, and grayish brown clay loam that extends to a depth of 33 inches; the lower part is grayish brown silt loam to a depth of 60 inches or more. This soil is strongly alkaline or very strongly alkaline.

Included with this soil in mapping are about 5 percent areas of Henley soil and 5 percent of Zuman soil. Also included are about 20 percent areas of soils that are silty clay loam to a depth of more than 60 inches and that

have a strong, very fine granular structure. The soil has the apparent texture of fine sand when dry.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of water erosion is moderate. There is a hazard of wind erosion in spring. Available water capacity is 11 to 18 inches and the water-supplying capacity for natural vegetation is 9 to 11 inches.

This soil is used mainly for range, but parts of a few areas have been leveled and are used for irrigated crops, mainly pasture. Some pastures are mostly saltgrass. Alfalfa and cereal hay are grown in some areas. If free of alkali, the soil can be used for most of the climatically suited crops in the survey area, for example, alfalfa hay, wheat, oats, barley, and cereal hay.

This soil is better suited to sprinkler irrigation than to other irrigation methods. Leveling, which requires very deep cuts in most areas, can be made without exposing layers of contrasting texture or layers with alkali content. Careful application of water is needed to prevent erosion in unleveled areas. Because most areas of this soil are at a higher elevation than the water supplies, pumping water upslope is needed to irrigate.

Leaching with irrigation water over a period of many years reduces excess sodium and salt content. Remaining spots of alkali and slick or dispersed spots that resist leaching may respond to sulfur or gypsum. Use of crop residue and addition of organic material improve soil structure and increase the rate of water intake on slick or dispersed spots. Hard crusts on these spots hinder or prevent seedling emergence.

A long term cropping system that uses more alkali sensitive crops is well suited to this soil as soon as the alkali content is reduced by leaching. Tall wheatgrass or alta fescue pasture can be grown for many years followed by barley hay, by alfalfa hay, and by wheat and oats.

The climax native plant community on this soil (fig. 9) is dominated by basin wildrye and Nuttall alkaligrass. Such alkali-tolerant forbs as spreading thelypodium commonly occur. Black greasewood and spiny hopsage are prominent; greasewood is the dominate shrub.

If the range site deteriorates, basin wildrye and other desirable grasses decrease and black greasewood strongly increases. If the site severely deteriorates, only greasewood, scattered forbs, and a few plants of hopsage remain and much ground is left bare under the

Seedbed preparation and seeding of tall wheatgrass are needed if the range is in poor condition. Plants for dryland seeding need to have good seedling vigor to be alkali-tolerant.

Because of slope, this soil has important limitations for such community uses are homesites, small buildings, and roads. Low strength and potential frost action also are limitations for roads. Susceptibility to piping and low strength limit the use of this soil material for dams and other embankments. This soil is used for a few rural homesites.

This soil is in capability subclass IVe.

42B-Lapine gravelly loamy coarse sand, 1 to 10 percent slopes. This excessively drained soil is on lava tablelands southeast of Sun Mountain. It formed in thick, air-laid mantles of pumiceous cinders and ash. The average slope is about 3 percent. Elevation ranges from 4,400 to 4,600 feet. The average annual precipitation is 18 to 30 inches, the average annual air temperature is 41 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 18 inches thick. The upper part is very dark grayish brown, gravelly loamy coarse sand about 4 inches thick, and the lower part is dark brown, gravelly and very gravelly loamy coarse sand about 14 inches thick. The upper part of the underlying material is brown, light olive brown, olive brown, or dark grayish brown, extremely gravelly or very gravelly coarse sand that extends to a depth of 46 inches; the lower part is light gray, light brownish gray, and white, extremely gravelly coarse sand to a depth of 60 inches. The cinders are finest in the surface layer and lower part of the underlying material (fig. 10).

Included with this soil in mapping are about 20 percent areas of Steiger soil and less than 1 percent areas of Rock outcrop.

Permeability is very rapid. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, or there is no runoff. The hazard of erosion is slight. Available water capacity is about 20 to 24 inches, but the water-supplying capacity is only about 17 to 19 inches, because of cool temperatures. Some spots, as much as 5 feet in diameter, have profiles which are dry throughout winter precipitation and spring thaw, and appear not to moisten over a period of many years.

This soil is used mainly for timber, wildlife habitat, and recreation. It produces scant forage and has only limited use for grazing livestock. The soil is well suited to the production of ponderosa pine. Trees are easily harvested by tractor logging except in winter and spring when the snow is deep. Windthrow is a severe hazard because of the very light weight of the cinders and ash in which the tree roots anchor. Seedlings of ponderosa pine have a fair rate of survival if locally grown planting stock is used and if the site has been adequately prepared. Douglas-fir, sugar pine, incense cedar, and white fir occur in mixed stands with ponderosa pine where annual precipitation is about 25 inches or more. These soils are suitable for the production of Christmas trees.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 10 to 35 percent canopy cover in a moderately stocked mixed-age stand. Lodgepole pine is subordinate. The understory is dominated mainly by western needlegrass. Perennial forbs are sparse. Antelope bitterbrush dominates the shrub layer.

As the herbaceous understory deteriorates, bitterbrush increases. If the understory severely deteriorates or if the soil is disturbed, lodgepole pine increases and dominates the tree cover in places. In this condition, only remnants of the sparse stand of herbaceous plants remain and much ground is left bare under the trees.

If the tree overstory is removed through logging, fire, or other disturbance, native plants, for example, Ross sedge, needlegrass, and bottlebrush squirreltail temporarily increase and provide considerable forage for a number of years.

Seeding of introduced plants generally is not practical because of unmanageable soil conditions related to fertility, texture, and frost heaving. Under a typical tree overstory herbaceous forage production is small. Mule deer commonly use this plant community during summer and fall for food and cover.

This soil is well suited to such community uses as homesites, small buildings, and roads. Seepage and contamination of ground water are potential hazards for lagoons and landfills. Although seepage and contamination of ground water can result, septic tank absorption fields placed in this soil can function for many years with few problems. Cutbanks tend to cave easily if shallow excavations are made in dry soil. This soil is not used for homesites.

This soil is in capability subclass Vls.

43E-Lapine gravelly loamy coarse sand, 10 to 40 percent north slopes. This excessively drained soil is on small escarpments that face north. It formed in a thick, air-laid mantle of pumiceous cinders and ash. Elevation ranges from 4,400 to 5,300 feet. The average annual precipitation is 18 to 30 inches, the average annual air temperature is 41 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 18 inches thick. The upper part is very dark grayish brown, gravelly loamy coarse sand about 4 inches thick, and the lower part is dark brown, gravelly and very gravelly loamy coarse sand about 14 inches thick. The upper part of the underlying material is brown, light olive brown, olive brown, or dark grayish brown, extremely gravelly or very gravelly coarse sand that extends to a depth of about 46 inches; the lower part is light gray, light brownish gray, and white, extremely gravelly coarse sand to a depth of 60 inches. The cinders are finest in the surface layer and in the lower part of the underlying material.

Included with this soil in mapping are about 20 percent narrow bands of Steiger soil that are along the bottoms of slopes and near the crests of slopes, about 10 percent areas of Shanahan soil near the crests of slopes, and about 1 percent areas of Rock outcrop.

Permeability is very rapid. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight unless the surface layer is frozen and water from melting snow cannot enter the soil. Under these conditions, particularly if the upper part of the soil has been disturbed by logging or road building, runoff is rapid and the soil is eroded when the surface layer thaws. Available water capacity is about 20 to 40 inches, but the water-supplying capacity is only about 17 to 19 inches, because of cool temperatures. Some spots, as much as 5 feet in diameter, have profiles that are dry throughout winter precipitation and spring thaw and appear not to moisten over a period of years.

This soil is used mainly for production of ponderosa pine, Douglas-fir, white fir, and sugar pine; and for recreation and wildlife habitat. It produces only scant forage and has limited use for grazing by livestock. The soil is well suited to production of ponderosa pine. Trees are harvested by tractor logging on slopes that range to about 30 percent, and by other logging methods where slopes exceed 30 percent. Logging commonly is discontinued in winter and spring when the snow is deep. Windthrow is a severe hazard because of the very light weight of cinders and ash in which tree roots anchor. Seedlings of ponderosa pine have a fair rate of survival if locally grown planting stock is used and if the site is adequately prepared. Douglas-fir, sugar pine, incense cedar, and white fir commonly occur in mixed stands with ponderosa pine. An increase in regeneration of white fir follows logging. This soil is suitable for Christmas trees.

The climax native vegetation on this soil is a mixed pine woodland community. There is about 25 percent canopy cover of ponderosa pine and sugar pine in a moderately stocked mixed-age stand. Lodgepole pine is subordinate. White fir is the dominant understory at higher elevations. The shrub layer is dominated by snowbrush and greenleaf manzanita. The herbaceous layer is a sparse stand of shade-tolerant plants; Ross sedge is common in the openings.

If the tree overstory is removed through logging or other disturbance, snowbrush and greenleaf manzanita increase and sedge and other herbaceous plants increase. However, on the more gentle slopes this condition may temporarily result in an increase in the native grasses and considerable forage can be provided for a number of years.

Seeding of introduced plants generally is not practical because of steep slopes and unmanageable soil conditions, for example, low fertility, texture, and frost heaving. Herbaceous forage production under a typical tree cover is small. Mule deer commonly use this community during summer and fall for food and cover.

Because of excessive slope, this soil has important limitations for such community uses as homesites, small buildings, and roads. Effluent from septic tank absorption fields may surface downslope as a result of slope steepness and irregularity. Cutbanks tend to cave easily if shallow excavations are made in dry soil. This soil is not used for homesites.

This soil is in capability subclass Vle.

44E-Lapine gravelly loamy coarse sand, 10 to 35 percent south slopes. This excessively drained soil is on escarpments that face south. It formed in a thick, air-laid deposit of pumiceous cinders and ash. The average slope is about 20 percent. Elevation ranges from 4,200 to 5,300 feet. The average annual precipitation is 18 to 30 inches, the average annual air temperature is 41 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 18 inches thick. The upper part is very dark grayish brown, gravelly loamy coarse sand about 4 inches thick, and the lower part is dark brown, gravelly and very gravelly loamy coarse sand about 14 inches thick. The upper part of the underlying material is brown, light olive brown, olive brown, or dark grayish brown, extremely gravelly or very gravelly coarse sand that extends to a depth of about 46 inches; the lower part is light gray, light brownish gray, and white, extremely gravelly coarse sand to a depth of about 60 inches. The cinders are finest in the surface layer and in the lower part of the underlying material.

Included with this soil in mapping are about 15 percent narrow bands of Steiger soil that are along the bottoms and crests of slopes, about 20 percent areas of Shanahan soil near the crests of slopes, and as much as 40 percent areas of Shanahan soil in a few places where the pumice mantle is comparatively thin. Areas of Rock outcrop make up about 1 percent of the map unit.

Permeability is very rapid. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight unless the surface layer is frozen and water from melting snow cannot enter the soil. Under these conditions, particularly if the upper part of the soil has been disturbed by logging or road building, runoff is rapid and considerable soil is eroded when the surface layer thaws. Available water capacity is about 20 to 24 inches, but the water-supplying capacity is only about 17 to 19 inches, because of the cool temperatures.

This soil is used mainly for timber, wildlife habitat, and recreation. It produces scant forage and has very limited use for grazing by livestock. The soil is well suited to the production of ponderosa pine. Trees can be harvested easily by tractor logging on slopes that range to about 30 percent; other logging methods are used in small areas where slopes exceed 30 percent. Logging commonly is discontinued in winter and spring when the snow is deep. Windthrow is a severe hazard because of the very light weight of cinders and ash in which tree roots anchor. Seedlings of ponderosa pine have a fair rate of survival if locally grown planting stock is used and if the site is adequately prepared. Some sugar pine occurs with ponderosa pine near the upper end of the elevational range for this soil.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is about 30 percent canopy cover in a moderately stocked mixed-age stand. Lodgepole pine, white fir, and sugar pine may occur as subordinates. Bitterbrush, snowbrush, and greenleaf manzanita dominate the shrub layer. The herbaceous layer is a sparse stand of shade-tolerant plants; western needlegrass is common in the openings.

As the tree overstory is removed by logging or other disturbances, shrub cover increases and needlegrass and other herbaceous plants decrease. This condition on the more gentle slopes may initially result in a temporary increase in the native grasses that provide considerable forage for a number of years.

Seeding of introduced plants generally is not practical, because of steep slopes and unmanageable soil conditions related to fertility, texture, and frost heaving. Mule deer generally use this community in summer and fall for food and cover.

Because of excessive slope, this soil has important limitations for such community uses as homesites, small buildings, and roads. Effluent from septic tank absorption fields may surface downslope as a result of slope steepness and irregularity. Cutbanks cave easily if shallow excavations are made in dry soil. This soil is not used for homesites.

This soil is in capability subclass Vle.

45F-Lapine gravelly loamy coarse sand, 35 to 55 percent south slopes. This excessively drained soil is on the higher slopes of Sun Mountain, on Sand Ridge, and on the escarpment north of Spring Creek. It formed in a thick air-laid deposit of pumiceous cinders and ash. The average slope is about 45 percent. Elevation ranges from 4,200 to 6,000 feet. The average annual precipitation is 18 to 35 inches, the average annual air temperature is 41 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 18 inches thick. The upper part is very dark grayish brown, gravelly loamy coarse sand about 4 inches thick, and the lower part is dark brown, gravelly and very gravelly loamy coarse sand about 14 inches thick. The upper part of the underlying material is brown, light olive brown, olive brown, or dark grayish brown, extremely gravelly or very gravelly coarse sand that extends to a depth of 46 inches; the lower part is light gray, light brownish gray, and white, extremely gravelly coarse sand to a depth of 60 inches. The cinders are finest in the surface layer and lower part of the underlying material.

Included with this soil in mapping are about 10 percent areas where the buried soil is at a depth of 25 to 40 inches, about 1 percent areas of Rock outcrop in the Sun Mountain and Sand Ridge areas, and about 10 percent areas of rimrock and other Rock outcrop north of Spring Creek.

Permeability is very rapid. Roots commonly penetrate to a depth of more than 60 inches, and generally they are more numerous in the buried soil than in the substratum. Runoff is very slow, and the hazard of erosion is slight unless the surface layer is frozen and water from melting snow cannot enter the soil. Under these conditions, particularly if the upper part of the soil has been disturbed by logging or road building, runoff is rapid and considerable soil is eroded when the surface layer thaws. Available water capacity is about 20 to 24 inches, but the water-supplying capacity is only about 17 to 19 inches, because of cool temperatures.

This soil is used mainly for timber, wildlife habitat, and recreation. It produces scant forage and has very limited use for grazing by livestock. The soil is well suited to the production of ponderosa pine. Most trees are harvested by such methods as cable logging that accommodate very steep slopes. Logging commonly is discontinued in winter and spring when the snow is deep. Windthrow is a severe hazard because of the very light weight of cinders and ash in which tree roots anchor. Seedlings of ponderosa pine have a fair rate of survival if locally grown planting stock is used and if the site is adequately prepared. Near the upper end of the elevational range for this soil, the overstory consists mainly of ponderosa pine, Douglas-fir, and sugar pine with a dense understory of snowbrush and golden chinquapin.

The climax vegetation on this soil is a ponderosa pine woodland community. There is about 30 percent canopy cover of ponderosa pine in a moderately stocked mixed-age stand. Lodgepole pine, white fir, and sugar pine may occur as subordinates. Bitterbrush, snowbrush, and greenleaf manzanita dominate the shrub layer. The herbaceous layer is a sparse stand of shade-tolerant plants; western needlegrass is common in the openings.

As the tree overstory is removed by logging or other disturbances, shrub cover increases and needlegrass and other herbaceous plants decrease. This condition on the more gentle slopes may first result in a temporary increase in the native grasses and can provide considerable forage for a number of years.

Seeding of introduced plants generally is not practical because of steep slopes and unmanageable soil conditions related to fertility, texture, and frost heaving. Mule deer generally use this plant community in summer and fall for food and cover.

Because of excessive slope, this soil has important limitations for nearly all community uses. This soil is not used for homesites.

This soil is in capability subclass Vle.

46-Lather muck. This very poorly drained, nearly level soil is on reclaimed bottoms west and south of Agency Lake and in other areas adjoining Upper Klamath Lake that have been diked and drained. The soils formed in very deep deposits of partly decomposed fibrous organic material that has one or more thin layers of diatomaceous silt. Elevation is about 4,145 feet. The average annual precipitation is 18 to 23 inches, the average annual air temperature is 42 to 44 degrees F, and the frost-free season is about 50 to 110 days.

Typically, the surface layer is about 13 inches thick. The upper part is black mucky peat about 6 inches thick, and the lower part is dark brown, fibrous mucky peat about 7 inches thick. The upper part of the underlying material is black, diatomaceous silt that extends to a depth of about 15 inches; the lower part is dark brown, fibrous mucky peat to a depth of 70 inches or more. The soil is medium acid to neutral in the upper part and strongly acid to slightly acid in the lower part.

Included with this soil in mapping are about 10 percent areas of soil where the surface layer is peat or mucky peat.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of water erosion is slight. The soil is subject to blowing when the surface layer dries and is disturbed by cultivation or vehicular traffic. There also is a hazard of fire when the upper part of the soil becomes dry. Available water capacity is 20 to 30 inches. The water table in this soil is controlled by pumping from drains. It mostly is at a depth of 0 to 3 feet. This soil is frequently flooded for long periods of time.

This soil is used mainly for irrigated pasture. Such crops as cereal hay, oats, and barley can be grown if the growing season is long enough. Yields of oats and barley are limited in many areas because of low amounts of potassium, phosphorus, copper, and zinc in the soil. Application of fertilizers that contain these elements may be needed for satisfactory yields of grain and forage legumes. Excessive amounts of molybdenum in relation to copper in forage plants, particularly legumes, may result in physiologic disorders in animals that graze this soil.

Subsidence in the first few years following drainage can be as much as 10 to 20 inches and as much as 1 inch per year thereafter. Unequal subsidence can be caused by variation in depth to the water table resulting from unequal drainage. Drains may need to be spaced closely enough to provide uniform depth to the water table and to afford adequate control of the water table for both irrigation and drainage. The water table can be controlled and maintained at a nearly constant level for optimum crop growth by pumping from canals and ditches. Surface unevenness can result from unequal compaction by farm machinery, vehicular traffic, fire, and grazing animals.

This soil is suited to sprinkler and border irrigation. Regardless of what method is used, maintaining uniform soil moisture above the water table to minimize unequal subsidence and reduce the hazard of fire is important. It is especially important to prevent the soil from drying completely in any part, because once it is dry, fibrous peaty material may be extremely difficult or impossible to rewet. The soil also can be subirrigated, but subirrigation can result in accumulation of excess sodium and salt in the upper part of the soil over a period of years. Alternative use of other irrigation methods at periodic, long term intervals is needed to maintain an acceptable salt balance in the soil where subirrigation is the usual method.

Wind erosion is an important consideration in crop production. Blowing of dry, pulverized organic material is particularly abrasive and damaging to young crop plants. In addition to soil loss, blowing material can fill ditches and canals and result in expensive maintenance.

Because of wetness, the hazard of flooding, and very low strength of the organic material, this soil is limited for community uses. Organic soils commonly are not considered as adequate sites for construction of dwellings, buildings, and other structures. Permanent dikes constructed from organic material are not considered feasible by most engineers without extensive modification in design such as mixing organic with mineral soil material and topping with 4 to 6 inches of sand wherever needed. An extensive layer of diatomaceous silt is at a depth of about 15 feet and is used as covering material for dikes and roads in the area south of Agency Lake. Side slopes need to be wide as compared to the height of the dike.

This soil is in capability subclass IVw.

47A-Lobert sandy loam, 0 to 2 percent slopes. This well drained soil is on terraces. It formed in alluvial and lacustrine sediment weathered from diatomaceous, tuffaceous sandstone that has a considerable amount of black sand, and a small amount of pumiceous ash. Slopes are uneven in those areas that were not leveled for irrigation. Elevation ranges from 4,200 to 4,400 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark brown sandy loam about 16 inches thick. The subsoil is very dark grayish brown, coarse sandy loam that extends to a depth of about 32 inches. The upper part of the substratum, to a depth of 42 inches, is dark brown sandy loam that has 10 percent firm and brittle nodules as much as 1/2 inch in diameter; the lower part is dark brown, firm, and brittle sandy clay loam to a depth of 60 inches or more.

Included with this soil in mapping are about 10 percent areas of soils that are as much as 3 acres in size where the substratum is calcareous at a depth below 20 inches; a few small areas of soils about 2 miles northwest of the town of Sprague River that mostly are calcareous at a depth below 20 inches; and parts of areas where the soils are weakly cemented at a depth of below 24 inches. Also included are a few areas of soils east of the town of Beatty that dominantly have a loamy coarse sand surface derived from ash, and parts of some areas of soils that have a substratum of gravelly loam and light clay loam.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 8 to 11 inches. The water-supplying capacity for natural vegetation is 12 to 16 inches.

Most of this soil was cleared and cultivated in the past, and many areas are presently used for both irrigated and dryland crops, for example, alfalfa hay, cereal hay, and pasture. Oats and rye are grown for cereal hay. Alta fescue and Kentucky bluegrass are suitable for irrigated pasture. Crested wheatgrass, intermediate wheatgrass, hard fescue, and alfalfa are suitable for dryland pasture. The growing season is too short for Irish potatoes. Some areas have a few scattered trees of ponderosa pine.

This soil is suited to sprinkler, graded border, and furrow irrigation. Furrows are not used because of the kinds of crops grown. Comparatively deep cuts can be made in leveling without exposing the relatively infertile substratum. Sprinklers allow accurate control of soil moisture for crops.

A tillage pan forms readily in this soil, particularly if cereal hay crops are grown in succession. Varying the depth of tillage, using minimum tillage, and occasionally deep plowing or chiseling prevent formation of such a pan. A cropping system of 6 to 8 years of alfalfa hay and 1 or 2 years of cereal hay is well suited to this soil. Use of crop residue improves tilth and soil structure.

This soil generally is well suited to such community uses as homesites, small buildings, and most types of sanitary facilities. Low strength and potential frost action limit the use of this soil material. Low strength, seepage, and the hazard of piping severely limit the use of this soil material for dams and other embankments. Seepage can also be a hazard for lagoons or landfills. This soil is used for many rural homesites.

This soil is in capability subclass IVc.

47B-Lobert sandy loam, 2 to 12 percent slopes. This well drained soil is on terraces and fans. It formed in alluvial and lacustrine sediment weathered from diatomite, tuff, and a small amount of pumiceous ash. Elevation ranges from 4,200 to 4,400 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark brown sandy loam about 16 inches thick. The subsoil is very dark grayish brown, coarse sandy loam that extends to a depth of about 32 inches. The upper part of the substratum, to a depth of 42 inches, is dark brown sandy loam that has 10 percent firm, and brittle nodules as much as 1/2 inch in diameter; the lower part is dark brown, firm, and brittle sandy clay loam to a depth of 60 inches or more.

Included with this soil in mapping are about 10 percent areas of soils that are underlain by tuffaceous bedrock or hardpan at a depth of 24 to 40 inches, about 5 percent areas of Choptie soil, and a few areas of soils where the substratum is gravelly loam and gravelly clay loam.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 8 to 11 inches. The water-supplying capacity for natural vegetation is 12 to 16 inches.

Most areas of this soil were cleared and cultivated in the past, and many soils now are used for irrigated and dryland crops, for example, alfalfa hay, cereal hay, and pasture. Oats and rye are grown for cereal hay. Alta fescue and Kentucky bluegrass are suitable for irrigated pasture. Crested wheatgrass, intermediate wheatgrass, hard fescue, and alfalfa are suitable for dryland pasture. The growing season is too short for Irish potatoes. Some areas have a few scattered trees of ponderosa pine.

This soil is best suited to sprinkler irrigation. Leveling to grade generally requires very deep cuts that expose the infertile substratum or bedrock. Leveled areas can be irrigated with borders on slopes of as much as 4 percent. Corrugations can be used on slopes to 8 percent. Sprinklers afford the most accurate control of soil moisture for crops. Any irrigation method requires careful adjustment of the rate of application of water to prevent erosion. Because most areas of this soil are at a higher elevation than the water supplies, pumping is commonly needed to irrigate.

A tillage pan forms readily in this soil, particularly if cereal hay crops are grown in succession. Varying the depth of tillage, using minimum tillage, and occasionally deep plowing or chiseling prevent formation of such a pan. Use of cereal hay and other crop residue improves tilth and soil structure and reduces soil loss from erosion. If the soil is irrigated, a suitable cropping system is 6 to 8 years of alfalfa hay or pasture and 1 or 2 years of cereal hay. In areas that are dryfarmed, using crop residue, farming across the slope, and fall chiseling after harvest can decrease runoff and soil loss from erosion and increase moisture available for future crops. Waterways between slopes need to be seeded to grass to prevent the formation of gullies. Permanent dryland pasture is well suited to this soil.

Because of slope and potential frost action, this soil has important limitations for such community uses as homesites, small buildings, and roads. Low strength limits the use of this soil material for roads. Low strength, susceptibility to piping, and possible seepage severely limit the use of this soil material for dams and other embankments. Seepage is also a hazard for lagoons or landfills. Some areas of this soil have been subdivided for homesites, and many rural dwellings have been built on it.

This soil is in capability subclass IVe.

48A-Lobert loam, 0 to 2 percent slopes. This well drained soil is on terraces near the edge of colder basins. It formed in alluvial and lacustrine sediment weathered from diatomaceous, tuffaceous sandstone that has a considerable amount of black sand, and a small amount of pumiceous ash. Most areas of the soil are woodland. Elevation ranges from 4,160 to 4,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsoil extends to a depth of about 41 inches. The upper part, to a depth of about 25 inches, is very dark grayish brown loam; the lower part, to a depth of 41 inches, is dark brown fine sandy loam. The substratum, to a depth of 60 inches or more, is dark brown fine sandy loam and loamy fine sand that has many firm and brittle nodules as much as 3 inches in diameter.

Included with this soil in mapping are about 10 percent areas where the soils are fine sandy loam throughout and about 10 percent areas of Bly soil that are mostly 2 acres or less in size. Also included are a few irrigated areas south of the Williamson River that have a water table at a depth of 2.5 to 4 feet during the period of irrigation. The substratum of the soils along the Williamson River is gravelly or very gravelly in places.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 8 to 13 inches. The water-supplying capacity is 12 to 16 inches.

This soil is used mainly for irrigated and dryland crops, timber, and grazing by livestock. Such crops as alfalfa hay, cereal hay, and pasture are grown. Oats and rye are grown for cereal hay. Alta fescue and Kentucky bluegrass are suitable for irrigated pasture. Irish potatoes are grown in some years in a few places south of the Williamson River and in the southern end of Swan Lake Valley. The growing season is too short for potatoes in other areas.

This soil is suited to sprinkler, graded border, and furrow irrigation. Comparatively deep cuts can be made in leveling for furrows and borders without exposing the infertile substratum. Sprinklers afford accurate control of soil moisture for crops. Deep drains may be needed to lower the water table in overirrigated areas.

A tillage pan forms readily in this soil, particularly if cereal hay crops are grown in succession. Varying the depth of tillage, using minimum tillage, and occasionally deep plowing or chiseling prevent formation of such a pan. A cropping system of 6 to 8 years of alfalfa hay and 1 or 2 years of cereal hay is well suited to this soil. Use of crop residue can improve tilth and soil structure.

This soil is well suited to the production of ponderosa pine. Timber is easily harvested by tractor logging except in winter when the snow is deep and in spring when the soil is wet. Pine seedlings planted on this soil have a high rate of survival if locally grown planting stock is used and if the site has been adequately prepared. Thinning is important for good stand development because site disturbance produces dense stands of seedlings and young trees.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 20 to 40 percent canopy cover in a moderately stocked mixed-age stand. The understory is dominated by Idaho fescue. A variety of perennial forbs grows throughout the stand. The shrub layer is dominated by antelope bitterbrush.

As the understory deteriorates, forage bunchgrasses decrease. Bitterbrush increases for a time; then it decreases. If the understory severely deteriorates, annual weeds and such low value shrubs as big sagebrush and rabbitbrush dominate the understory. Deterioration of the understory commonly results in dense clumps of pine reproduction.

Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, hard fescue, and alfalfa are suitable for dryland seeding. Mule deer commonly use this community in summer and fall months for food and cover.

This soil is generally well suited to such community uses as homesites, small buildings, and most types of sanitary facilities. Low strength and potential frost action limit the use of this soil material for roads. Low strength, seepage, and the hazard of piping severely limit the use of this soil material for dams and other embankments. This soil is used for many rural homesites.

This soil is in capability subclass IVc.

48B-Lobert loam, 2 to 5 percent slopes. This well drained soil is on terraces near the edge of colder basins. It formed in alluvial and lacustrine sediment weathered from diatomaceous, tuffaceous sandstone that has a considerable amount of black sand, and a small amount of pumiceous ash. Elevation ranges from 4,160 to 4,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsoil extends to a depth of about 41 inches. The upper part, to a depth of about 25 inches, is very dark grayish brown loam; the lower part, to a depth of about 41 inches, is dark brown fine sandy loam. The substratum, to a depth of 60 inches or more, is dark brown fine sandy loam and loamy fine sand that has many firm and brittle nodules as much as 3 inches in diameter.

Included with this soil in mapping are about 10 percent areas of soils that are underlain by diatomite or tuff at a depth of 20 to 40 inches, and many small areas of soils where depth to bedrock or hardpan is 40 to 60 inches. Also included are about 15 percent areas of Bly soil.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is slow. The hazard of erosion is slight under natural conditions but is intensified if the soil is dryfarmed or irrigated. Available water capacity is 8 to 13 inches. The water-supplying capacity for natural vegetation is 12 to 16 inches.

This soil is used mainly for timber, grazing by livestock, and wildlife habitat. Some areas have been cleared and irrigated and dryland crops are grown. Alfalfa hay, cereal hay, and pasture are the main crops. Oats and rye mostly are grown for cereal hay. Alta fescue and Kentucky bluegrass are suitable for irrigated pasture. The growing season mostly is too short for Irish potatoes.

This soil is well suited to sprinkler irrigation. Leveled areas can be irrigated by borders on slopes that range to 4 percent. Furrows can be used across the slope if the furrow slope does not exceed 2 percent. Furrows, however, commonly are not used to irrigate because of the kinds of crops grown. Corrugations also can be used. Leveling generally requires very deep cuts that can expose the infertile underlying layer. Sprinklers afford accurate control of soil moisture for crops. Rate of application of water needs to be carefully adjusted to prevent erosion. Because most areas of this soil are at a higher elevation than the water supplies, pumping commonly is needed to irrigate.

A tillage pan forms readily in this soil, particularly if cereal hay crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent formation of such a pan. Use of cereal hay and other crop residue improves soil tilth and structure and reduces soil loss from erosion. A suitable cropping system is 6 to 8 years of alfalfa hay or pasture followed by 1 or 2 years of cereal hay. On dryland, use of crop residue, farming across the slope, and fall chiseling after harvest decrease runoff and erosion and increase soil moisture for future crops.

This soil is well suited to the production of ponderosa pine. Timber is easily harvested by tractor logging except in winter when the snow is deep and spring when the soil is too wet. Pine seedlings planted on this soil have a high rate of survival if locally grown planting stock is used and if the site has been adequately prepared. Thinning is important for good stand development because site disturbance produces dense stands of seedlings and young trees.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 20 to 40 percent canopy cover in a moderately stocked mixed-age stand. The understory is dominated by Idaho fescue. A variety of perennial forbs occurs throughout the stand. The shrub layer is dominated by antelope bitterbrush.

As the understory deteriorates, forage bunchgrasses decrease. Bitterbrush increases for a time; then it decreases. If the understory severely deteriorates, annual weeds and such low value shrubs as big sagebrush and rabbitbrush dominate the understory. Deterioration of the understory commonly results in dense clumps of pine reproduction.

Following fire or logging, broadcast seedling before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, hard fescue, and alfalfa are suitable for dryland seeding. Mule deer commonly use this community in summer and fall for food and cover.

This soil is generally suited to such community uses as homesites, small buildings, and most types of sanitary facilities. Low strength and potential frost action limit the use of this soil material for roads. Low strength, seepage, and the hazard of piping severely limit the use of this soil material for dams and other embankments. This soil is used for many rural homesites.

This soil is in capability subclass IVe.

48C-Lobert loam, 5 to 15 percent slopes. This well drained soil is on sloping parts of terraces near the edge of colder basins. It formed in alluvial and lacustrine sediment weathered from diatomaceous, tuffaceous sandstone that has a considerable amount of black sand, and a small amount of pumiceous ash. Elevation ranges from 4,160 to 4,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsoil extends to a depth of about 41 inches. The upper part, to a depth of about 25 inches, is very dark grayish brown loam; the lower part, to a depth of about 41 inches, is dark brown fine sandy loam. The substratum, to a depth of 60 inches or more, is dark brown fine sandy loam and loamy fine sand that has many firm and brittle nodules as much as 3 inches in diameter.

Included with this soil in mapping are about 15 percent areas of soils where the depth to diatomite or tuff is 20 to 40 inches, areas of soil that have bedrock at a depth of 40 to 60 inches, and about 5 percent areas of Bly soil. Also included are areas where the surface of the soil is stony, and about 1 percent small ledges of Rock outcrop.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 8 to 13 inches. The water-supplying capacity for natural vegetation is 12 to 16 inches.

This soil is used mainly for timber, grazing by livestock, and wildlife habitat. A few areas were cleared and irrigated and dryland alfalfa hay, cereal hay, and pasture are grown. Oats and rye mostly are grown for cereal hay. Alta fescue and Kentucky bluegrass are suitable for pasture. Slopes mostly are too steep, and the growing season is too short for Irish potatoes.

This soil is better suited to sprinkler irrigation than to other irrigation methods. Leveling commonly requires very deep cuts that expose bedrock or the infertile underlying layers in many places. Rate of application needs to be carefully adjusted to prevent erosion. Because most areas of this soil are at a higher elevation than the water supplies, water needs to be pumped from canals and ditches to irrigate.

A tillage pan forms readily in this soil, particularly if cereal hay crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing can prevent formation of such a pan. Use of cereal hay and other crop residue improves tilth and soil structure and reduces soil loss from erosion. A suitable cropping system is 6 to 8 years of alfalfa hay or pasture and 1 or 2 years of cereal hay. In areas that are dryfarmed, using crop residue, farming across the slope, and fall chiseling after harvest decrease runoff and soil loss from erosion and increase soil moisture available for future crops. Waterways between slopes need to be seeded to grass to prevent gullying.

This soil is well suited to the production of ponderosa pine. Timber is easily harvested by tractor logging except in winter when the snow is deep and spring when the soil is too wet. Pine seedlings planted on this soil have a high rate of survival if locally grown planting stock is used and if the site has been adequately prepared. Thinning is important for good stand development because site disturbance produces dense stands of seedlings and young trees.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 20 to 40 percent canopy cover in a moderately stocked mixed-age stand. The understory is dominated by Idaho fescue. A variety of perennial forbs occurs throughout the stand. The shrub layer is dominated by antelope bitterbrush.

As the understory deteriorates, forage bunchgrasses decrease. Bitterbrush increases for a time; then it decreases. If the understory severely deteriorates, annual weeds and such low value shrubs as big sagebrush and rabbitbrush dominate the understory. Deterioration of the understory commonly results in dense clumps of pine reproduction.

Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, hard fescue, and alfalfa are suitable for dryland seeding. Mule deer commonly use this community in summer and fall for food and cover.

Because of slope and potential frost action, this soil has limitations for such community uses as homesites, small buildings, and roads. Low strength and potential frost action also limit the use of this soil material for roads. Low strength, susceptibility to piping, and possible seepage severely limit the use of this soil material for dams and other embankments. Some areas of this soil north of the Williamson River have been subdivided for homesites.

This soil is in capability subclass IVe.

48D-Lobert loam, 15 to 25 percent slopes. This well drained soil is on steep parts of terraces. It formed in alluvial lacustrine sediment weathered from diatomaceous, tuffaceous sandstone that has a considerable amount of black sand, and a small amount of pumiceous ash. Elevation ranges from 4,300 to 4,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsoil extends to a depth of 41 inches. The upper part, to a depth of 25 inches, is very dark grayish brown loam; the lower part, to a depth of about 41 inches, is dark brown fine sandy loam. The substratum, to a depth of 60 inches or more, is dark brown fine sandy loam and loamy fine sand that has many firm and brittle nodules as much as 3 inches in diameter.

Included with this soil in mapping are about 15 percent areas of soils where the depth to diatomite or tuff is about 20 to 40 inches, many areas of soils where depth to bedrock is 40 to 60 inches, and about 2 percent ledges and outcroppings of bedrock. Scattered stony patches are near the areas of Rock outcrop.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium. The hazard of erosion is moderate but is intensified under irrigation or dryfarming. Available water capacity is 8 to 13 inches. The water-supplying capacity for natural vegetation is 12 to 16 inches.

This soil is used mainly for woodland, grazing by livestock, and wildlife habitat. Only a small acreage has been cleared for cropland, and mainly alfalfa hay and pasture are grown. Alta fescue and Kentucky bluegrass are suitable for irrigated pasture. Slopes mostly are steep; only close growing crops can be grown because of the hazard of erosion.

This soil is better suited to sprinkler irrigation than to other irrigation methods because of steepness and irregularity of slopes. Because all areas of this soil are at a higher elevation than the water supplies, pumping is needed to irrigate.

This soil is well suited to the production of ponderosa pine. Timber is harvested by tractor logging except in winter when the snow is deep and spring when the soil is too wet. Pine seedlings planted on this soil have a high rate of survival if locally grown planting stock is used and if the site has been adequately prepared. Thinning is important for good stand development because site disturbance produces dense stands of seedlings and young trees.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 20 to 40 percent canopy cover in a moderately stocked mixed-age stand. The understory is dominated by Idaho fescue. A variety of perennial forbs occurs throughout the stand. The shrub layer is dominated by antelope bitterbrush.

As the understory deteriorates, forage bunchgrasses decrease. Bitterbrush increases for a time; then it decreases. With severe deterioration, annual weeds and such low value shrubs as big sagebrush and rabbitbrush dominate the understory. Deterioration of the understory commonly results in dense clumps of pine reproduction.

Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, hard fescue, and alfalfa are suitable for dryland seeding. Mule deer commonly use this plant community in summer and fall for food and cover.

Because of steepness of slope, this soil has important limitations for such community uses as homesites, small buildings, roads, and most sanitary facilities. Low strength, susceptibility to piping, and possible seepage are severe limitations if the soil material is used for dams and other embankments. This soil is used in a few places for homesites.

This soil is in capability subclass IVe.

49C-Lorella loam, 1 to 15 percent slopes. This well drained soil is on rock benches near the edge of warmer basins. It formed in very cobbly and gravelly material weathered mainly from tuff and basalt. Elevation ranges from 4,140 to 4,400 feet. The average annual precipitation is 12 to 16 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark grayish brown loam about 5 inches thick. The subsoil extends to a depth of about 19 inches. The upper part is dark brown, very cobbly clay loam to a depth of about 10 inches, and the lower part is dark yellowish brown, very cobbly clay to a depth of 19 inches. Hard tuffaceous bedrock is at a depth of 19 inches.

Included with this soil in mapping are about 15 percent areas of Dodes soil that are mostly less than 2 acres in size; and a few areas near the northern area of Langell Valley, as much as 10 acres in size, of a loamy soil that is underlain by bedrock at a depth of 4 to 10 inches. Also included are about 2 percent areas of Rock outcrop and about 10 percent stony or very stony areas that are 1 acre to 3 acres in size.

Permeability is slow. Roots commonly penetrate to a depth of 10 to 20 inches. Runoff is rapid, and the hazard of erosion is high. Available water capacity is as low as 1 inch where depth to bedrock is 10 inches and many pebbles are present; it is as high as 3 inches where depth to bedrock is 20 inches and few pebbles are present. The water-supplying capacity for natural vegetation is 5 to 8 inches.

This soil mainly is used for range and wildlife habitat. Some areas of this soil that are at a lower elevation than the water supplies are used for irrigated pasture. Kentucky bluegrass and alta fescue are suitable for irrigated pasture. Other areas that are at a higher elevation than the water supplies have been cleared of western juniper and brush and are seeded to wheatgrass.

Most areas are irrigated by uncontrolled flooding. Leveling this soil is impractical because of undulating slopes and shallow depth to bedrock. Sprinklers are better suited than other irrigation methods and provide uniform control of soil moisture for plants.

The climax native vegetation on this soil is a plant community dominated by western juniper with about 10 to 15 percent canopy cover. Bluebunch wheatgrass is the dominant understory grass. Idaho fescue and Sandberg bluegrass are prominent. A variety of perennial forbs grows throughout the stand. Antelope bitterbrush and lesser amounts of big sagebrush are the dominant shrubs.

If the range deteriorates, bluebunch wheatgrass, Idaho fescue, and bitterbrush decrease and forbs, big sagebrush, and juniper increase. If the site severely deteriorates, the bunchgrasses and such desirable shrubs as big sagebrush are nearly eliminated. In this condition, much ground is left bare under the junipers and the hazard of soil erosion is high. If deterioration is a result of recurring fire, juniper is nearly eliminated, and low value shrubs dominate the range site.

Seedbed preparation and seeding are needed on this soil if the range is in poor condition. Crested wheatgrass and ladak alfalfa are suitable for dryland seeding. Wildlife values, especially food and cover for deer winter range, should be considered when planning management alternatives.

Because of shallow depth to hard bedrock and the tendency of the subsoil to shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. Shallow soil depth and slow permeability commonly cause septic tank absorption fields placed in this soil to fail.

This soil is in capability subclass IVe irrigated and VIe nonirrigated.

50E-Lorella very stony loam, 2 to 35 percent south slopes. This well drained soil is on escarpments at the edge of warmer basins that mostly face south. It formed in very cobbly and gravelly material weathered from tuff and basalt. Slopes are convex. The average slope is about 20 percent. Elevation ranges from 4,140 to 5,500 feet. The average annual precipitation is 12 to 16 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is about 5 inches thick. The upper part is very dark grayish brown, very stony loam about 2 inches thick, and the lower part is very dark grayish brown, very gravelly loam about 3 inches thick. The upper part of the subsoil is dark brown, very cobbly clay loam that extends to a depth of about 10 inches; the lower part is dark yellowish brown, very cobbly clay to a depth of about 19 inches. Hard tuffaceous bedrock is at a depth of 19 inches. The surface ranges from slightly stony to extremely stony and cobbly.

Included with this soil in mapping are about 5 percent areas of Calimus and Capona soils, about 10 percent areas of Stukel soil, and about 5 percent areas of rimrock and other Rock outcrop.

Permeability is slow. Roots commonly penetrate to a depth of 10 to 20 inches. Runoff is rapid, and the hazard of erosion is high during spring runoff and following fire or excessive grazing. Available water capacity is as low as 1 inch where depth to bedrock is 10 inches; it is as high as 3 inches where depth to bedrock is 20 inches. The water-supplying capacity for natural vegetation is 5 to 8 inches.

Nearly all areas of this soil are used for range and wildlife habitat. A few areas near the southern end of Langell Valley below irrigation ditches are irrigated by wild flooding. The soil generally is too stony and steep for cultivating or for use of farm machinery.

The climax native vegetation on this soil (fig. 11) is a plant community dominated by western juniper with about 15 percent canopy cover. Bluebunch wheatgrass and Thurber needlegrass are prominent understory grasses. A variety of perennial forbs grows throughout the stand. Antelope bitterbrush and big sagebrush are dominant shrubs.

If the range site deteriorates, bitterbrush and bluebunch wheatgrass decrease and forbs, big sagebrush, and juniper increase. If the site severely deteriorates, the bunchgrasses and such desirable shrubs as big sagebrush are nearly eliminated. In this condition, ground is left bare under the juniper and hazard of soil erosion is high. If the deterioration is a result of recurring fire, juniper is nearly eliminated and low value shrubs dominate the range site.

Seedbed preparation and seeding of poor condition range generally are not practical because of very stony and shallow soils. Wildlife values, especially food and cover needs for deer winter range, should be considered in planning management alternatives.

Because of slope, shallow depth to hard bedrock and the tendency of the subsoil to shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. Shallow soil depth, slow permeability, and excessive slope can cause septic tank absorption fields placed in this soil to fail in a few years.

This soil is in capability subclass VIls.

51E-Lorella-Calimus association, steep north slopes. The well drained soils in this association are on escarpments at the edge of warmer basins that dominantly face north. The Lorella soil formed in very cobbly and gravelly material weathered from tuff and basalt. The Calimus soil formed in loamy lacustrine sediment. Slopes are 15 to 35 percent. Elevation ranges from 4,140 to 4,700 feet. The average annual precipitation is 12 to 16 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 100 days.

This association is mainly about 60 percent Lorella very stony loam, 15 to 35 percent north slopes, and about 25 percent Calimus loam, 15 to 35 percent slopes. The Lorella soil generally is on the upper part of the slightly more convex side slopes, and the Calimus soil is on the lower part. In places, however, the Lorella soil fingers into the lower part. The proportions of these soils vary among areas. Included in the association are about 10 percent areas of Capona, Stukel, and Dodes soils; about 5 percent rimrock and other Rock outcrop; and, in a few areas, about 25 percent Harriman loam, 15 to 35 percent slopes.

Typically, the Lorella soil has a surface layer about 5 inches thick. The upper part is very dark grayish brown, very stony loam about 2 inches thick, and the lower part is very dark grayish brown, very gravelly loam about 3 inches thick. The subsoil extends to a depth of about 19 inches. The upper part, to a depth of about 10 inches, is dark brown, very cobbly clay loam; the lower part, to a depth of about 19 inches, is dark yellowish brown, very cobbly clay. Hard tuffaceous bedrock is at a depth of 19 inches. The surface of the soil is slightly stony to extremely stony and cobbly.

Permeability is slow in the Lorella soil. Roots commonly penetrate to a depth of 10 to 20 inches. Runoff is rapid, and the hazard of erosion is high during spring runoff and following fire and excessive grazing. Available water capacity is as low as 1 inch where depth to bedrock is 10 inches; it is as high as 3 inches where depth to bedrock is 20 inches. The water-supplying capacity for natural vegetation is 5 to 8 inches.

Typically, the Calimus soil has a very dark brown loam surface layer about 14 inches thick. The subsoil is very dark brown, heavy loam about 34 inches thick. The substratum, to a depth of 60 inches, is dark brown loam.

Permeability is moderate in the Calimus soil. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 9 to 13 inches. The water-supplying capacity for natural vegetation is 10 to 12 inches.

This association is used mostly for range and wildlife habitat. In a few places, the Calimus soil has been seeded to wheatgrasses for dryland pasture.

The climax native plant community on this association (fig. 12) is dominated by Idaho fescue. Bluebunch wheatgrass is prominent. A wide variety of perennial forbs grows throughout the stand. A variety of desirable shrubs commonly occurs; antelope bitterbrush is the most prominent.

If the range site deteriorates, bluebunch wheatgrass and Idaho fescue decrease and big sagebrush strongly increases and dominates the stand. If the site severely deteriorates, the bunchgrasses and desirable shrubs are nearly eliminated, much ground is left bare, and the hazard of soil erosion is high. Western juniper invades from adjacent ridgetops, and if there is no periodic fire, juniper reproduction dominates the association in places.

Seedbed preparation and seeding of poor condition range generally is not practical because this association mostly is shallow and stony. Wildlife values of the total plant community, especially for deer, should be considered in planning management alternatives.

Because of excessive slope and shallow depth to bedrock on the Lorella soil, the soils in this association have important limitations for such community uses as homesites, small buildings, roads, lagoons, and landfills. Shallow soil depth, slow permeability, and excessive slope can cause septic tank absorption fields in the Lorella soil to fail in a few years. Low strength, susceptibility to piping, and the possibility of seepage severely limit the use of the Calimus soil for dams and other embankments. Some areas of this association near Klamath Falls are used for homesites.

The Lorella soil is in capability subclass Vlls; the Calimus soil is in capability subclass Vie.

52B-Maklak gravelly loamy coarse sand, 1 to 12 percent slopes. This excessively drained soil is on pumice flows that filled glacial valleys. It formed in pumiceous and scoriaceous cinders and ash. Slopes are about 4 percent. Elevation ranges from 4,400 to 4,750 feet. The average annual precipitation is 30 to 35 inches, the average annual air temperature is 41 to 44 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is very dark brown, gravelly loamy coarse sand about 3 inches thick. The upper part of the underlying material is dark brown, very gravelly loamy coarse sand that extends to a depth of about 27 inches; the lower part is dark reddish brown, extremely gravelly loamy coarse sand to a depth of 60 inches or more.

Included with this soil in mapping are about 10 percent spots of Steiger soil and less than 1 percent spots of Rock outcrop.

Permeability is rapid. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 12 to 24 inches. The water-supplying capacity for natural vegetation is 17 to 19 inches.

This soil is used for timber, wildlife habitat, and recreation. It is grazed to a very limited extent by livestock.

This soil is well suited to the production of ponderosa pine. Lodgepole pine, sugar pine, Douglas-fir, white fir, and quaking aspen also occur in the stand. Trees can be easily harvested by tractor logging except in winter and early in spring when the snow is deep. Windthrow is a hazard because the cinders and ash in which tree roots anchor have little weight. Ponderosa pine seedlings have a good rate of survival if the planting site has been adequately prepared and if locally grown planting stock is used. The soil also is suitable for Christmas trees.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is a 15 to 45 percent canopy cover in a moderately stocked mixed-age stand. Lodgepole pine is subordinate, and white fir may occur in smaller amounts. The understory is dominated by longstolon sedge. Such perennial forbs as strawberry are sparse. Snowbrush and greenleaf manzanita are prominent in the shrub layer.

As the understory deteriorates, sedge decreases and greenleaf manzanita and lodgepole pine increase. If the understory severely deteriorates or if the soil is disturbed, lodgepole pine dominates the tree cover in places. In this condition, much ground is left bare under the trees.

If the tree cover is removed by logging or other disturbances, a change in the microclimate occurs. Longstolon sedge and the native grasses temporarily increase and provide considerable forage for a number of years. Seeding of introduced plants generally is not practical because of unmanageable soil conditions related to fertility, texture, and frost heaving. Mule deer commonly use this plant community in summer and fall for food and cover.

Potential frost action is the main limitation for such community uses as homesites, small buildings, and roads. Seepage is also a limitation for lagoons and landfillls and if the soil material is used for embankments. Cutbanks cave if excavations are made in dry soil. This soil is not used for homesites.

This soil is in capability subclass Vls.

53-Malin clay loam. This somewhat poorly drained, nearly level soil is on flood plains. It formed in alluvial and lacustrine sediment weathered from tuff, basalt, diatomite, and ash. The soil has sufficient sodium to interfere with the growth of most crop plants. Elevation ranges from 4,050 to 4,185 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is about 21 inches thick. The upper part is black clay loam about 6 inches thick, and the lower part is black silty clay or clay loam about 15 inches thick. The underlying material is very dark grayish brown, mottled clay loam to a depth of 60 inches or more. The upper part of the profile is strongly alkaline and very strongly alkaline, and the lower part is moderately alkaline to strongly alkaline.

Included with this soil in mapping are about 10 percent areas of Scherrard soil and about 20 percent areas of soils that are only mildly alkaline or moderately alkaline. Also included is a large area of soils in Swan Lake Valley that are mildly alkaline and moderately alkaline and noncalcareous over about 40 percent of the area, and strongly alkaline over the rest; and small areas of soils along Buck Creek and a few other places where the substratum is fine sandy loam below a depth of 20 inches.

Permeability is slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 9 to 14 inches. A water table is at a depth of 1.5 to 5 feet during the period of irrigation and mostly it is at a depth of about 2 1/2 feet. The soil is subject to occasional brief flooding from March to May, but the area in Swan Lake Valley floods annually. Many areas along the Lost River are protected from flooding by dikes.

This soil is used mainly for irrigated pasture. Barley for grain or hay can be grown in drained and protected areas. Most of the soil has too much sodium to be used for wheat, oats, and alfalfa hay. Alta fescue commonly is grown for pasture, but tall wheatgrass is more suitable for areas that have a high amount of sodium in the soil. The area in Swan Lake Valley is native meadow that consists mainly of Baltic rush and inland saltgrass.

This soil is suited to sprinkler, border, and furrow irrigation. Furrows commonly are not used because of the kinds of crops grown. Careful design of sprinkler systems is needed because of the slow water intake rate. Irrigation with sprinklers affords accurate control of soil moisture for crops. Overirrigation can leach soluble plant nutrients, including nitrogen, below the root zone of crops. Comparatively deep cuts can be made in leveling without exposing layers of contrasting texture and fertility.

Leaching with irrigation water over a period of many years can reduce alkali content if the water table has been lowered sufficiently by drainage. Alkali and dispersed spots that resist leaching may respond to gypsum or sulfur. Hard crusts commonly form on these spots that hinder or prevent seedling emergence. Application of available organic material softens these crusts and improves soil structure in the surface layer. Because of slow permeability, this soil is more difficult to reclaim than other loamy soils in the survey area that contain sodium.

Suitable crops and cropping systems vary considerably depending on amounts of sodium and salt in the soil and on depth to the water table. Alta fescue or tall wheatgrass for pasture can grow in wet areas that have large amounts of alkali. In areas that have been drained and irrigated for many years, a cropping system of 5 or 6 years of alfalfa hay and 1 year of barley can be used.

Because of wetness, the hazard of flooding, and the tendency of the upper part of the soil to shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. Wetness and slow permeability can cause septic tank absorption fields placed in this soil to fail in a few years. Because of failure or partial failure of absorption fields on this soil, a large sanitary district sewer system has been constructed for suburban areas south of Klamath Falls.

This soil is in capability subclass IVw.

54-Malin Variant silt loam. This somewhat poorly drained, nearly level soil is on circular, concave lakebeds. It formed in lacustrine sediment weathered from diatomite, tuff, basalt, and ash. The soil has sufficient sodium to interfere with the growth of most crop plants. Elevation is 4,090 to 4,160 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsoil extends to a depth of about 16 inches. The upper part, to a depth of 10 inches, is very dark grayish brown silty clay loam; the lower part, to a depth of 16 inches, is dark grayish brown silty clay loam that has lime mottles. The substratum also has lime mottles. It is dark grayish brown silty clay loam to a depth of 60 inches or more. The profile is strongly alkaline or very strongly alkaline and is calcareous.

Included with this soil in mapping are about 10 percent playa-like areas that are barren of vegetation as much as 1 acre in size and about 10 percent areas of Malin soil.

Permeability is very slow. Roots commonly penetrate to a depth of more than 60 inches. There is no runoff, and this soil is intermittently ponded. The hazard of water erosion is slight. Available water capacity is 12 to 14 inches. A water table is at a depth of 0 to 3.5 feet from March to October. The soil is subject to frequent flooding from March to May unless runoff is controlled by dikes.

This soil is used mainly for pasture and wildlife habitat. Little has been done to free the soil of alkali or to grow such plants as alta fescue and tall wheatgrass for improved pasture. Because of the sodium and salt in the soil, only scattered patches of inland saltgrass, sparse amounts of stunted green rabbitbrush, and a few alkali-tolerant weeds grow in the area. The soil is used to some extent as feeding and holding areas for livestock.

This soil is well suited to border irrigation. Sprinkler systems need to be carefully designed, because of the very slow water intake rate. Only very thin cuts are needed to level this soil.

Leaching with irrigation water over a period of many years can reduce excess sodium and salt content if the water table has been lowered to a sufficient depth. Alkali and dispersed spots that resist leaching may respond to gypsum or sulfur. Drainage is difficult because the soil lacks a natural drainage outlet, and pumping is needed. Application of organic material can soften the hard surface crust that forms in the upper part of the surface layer. These crusts can hinder or prevent seedling emergence and water entry. Organic material also helps reduce the sodium content.

Tall wheatgrass is suitable for most areas after drainage is provided. Alta fescue is suited if sufficient reduction of alkali has occurred. Barley can be grown for hay in the partially reclaimed areas.

Because of wetness, the hazard of flooding, and low strength, this soil has important limitations for such community uses as homesites, small buildings, and roads. Very slow permeability, flooding, and wetness can cause septic tank absorption fields to fail in a few years. This soil is not used for homesites.

This soil is in capability subclass IVw.

55B-Maset coarse sandy loam, 1 to 12 percent slopes. This well drained soil is on rock benches. It formed in a thin mantle of ash on a loamy buried soil. Bedrock is at a depth of 20 to 40 inches. The average slope is about 4 percent, but parts of some areas have slopes to 20 percent. Elevation ranges from 4,200 to 4,800 feet. The average annual precipitation is 17 to 20 inches, the average annual air temperature is 42 to 44 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is very dark grayish brown coarse sandy loam about 8 inches thick. The upper part of the underlying material is dark brown, gravelly coarse sandy loam that extends to a depth of about 21 inches. The lower part is a buried soil that is dark brown, very gravelly clay loam over weathered bedrock at a depth of 32 inches. The surface layer and upper part of the underlying material are mainly ash.

Included with this soil in mapping are about 10 percent areas of soils where depth to bedrock is 10 to 20 inches, about 10 percent areas of soils where depth to bedrock is 40 to more than 60 inches, about 1 percent areas of Rock outcrop, and about 2 percent very stony patches. A few areas were included where the upper part of the soil is loam that has about 40 to 60 percent ash.

Permeability is moderately slow. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is as low as 5 inches where depth to bedrock is 20 inches and many pebbles are present; it is as high as 11 inches where the ashy upper part of the soil is 35 inches thick and where depth to bedrock is 40 inches. The water-supplying capacity for natural vegetation is 12 to 17 inches.

This soil is used mainly for timber and grazing by livestock. Parts of some areas have been subdivided for rural homesites. A few areas, mostly small, were cleared and irrigated crops of alfalfa hay, cereal hay, and pasture are grown. Oats and rye are suitable for hay. Oats for grain and wheat, barley, and Irish potatoes are not suitable crops because the growing season is too short in most years.

This soil is better suited to sprinklers than to other irrigation methods. Deep cuts which are needed in leveling for borders because of slope unevenness expose bedrock in many places. Rate of application of water needs to be carefully adjusted to prevent erosion on steeper parts of the soil.

This soil is well suited to the production of ponderosa pine. Timber is easily harvested by tractor logging except in winter and early in spring when the snow is deep. Windthrow is a hazard because of the light weight of ash in which the tree roots anchor. Seedlings of ponderosa pine planted in this soil have a fair rate of survival if locally grown planting stock is used and if the site has been adequately prepared.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 20 to 40 percent canopy cover in a moderately stocked mixed-age stand. The understory is dominated by Idaho fescue. A variety of perennial forbs occurs throughout the stand. The shrub layer is dominated by antelope bitterbrush.

As the understory deteriorates, forage bunchgrasses decrease. Bitterbrush increases for a time; then it decreases. If the understory severely deteriorates, annual weeds and such low value shrubs as big sagebrush and rabbitbrush dominate the understory. Deterioration of the understory commonly results in dense clumps of pine reproduction.

Land clearing for irrigation or dryland crop production is a suitable practice on the more gentle slopes of this soil. Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, hard fescue, and alfalfa are suitable for dryland seeding. Mule deer commonly use this plant community during summer and fall for food and cover.

Because of moderate depth to bedrock, this soil has important limitations for such community uses as homesites, roads, lagoons, and landfill trenches. Moderate soil depth and moderately slow permeability in the buried soil can cause septic tank absorption fields to function poorly and fail in a few years. Many homesites are on this soil.

This soil is in capability subclass VIe.

55E-Maset coarse sandy loam, 12 to 45 percent north slopes. This well drained soil is on escarpments and volcanic hills. It formed in a thin mantle of ash on a loamy buried soil. Bedrock is at a depth of 20 to 40 inches. The average slope is about 30 percent. Slopes predominantly face north. Elevation ranges from 4,200 to 5,500 feet. The average annual precipitation is 17 to 20 inches, the average annual air temperature is 41 to 44 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is very dark grayish brown, coarse sandy loam about 8 inches thick. The upper part of the underlying material is dark brown, gravelly coarse sandy loam that extends to a depth of about 21 inches. The lower part is a buried soil that is dark brown, very gravelly clay loam over weathered bedrock at a depth of 32 inches. The surface layer and upper part of the underlying material are mainly ash.

Included with this soil in mapping are about 15 percent areas of Yawhee soil, about 5 percent areas of Shanahan soil and 5 percent Steiger soil, and about 5 percent areas of soil where bedrock is at a depth of 12 to 20 inches. Also included is about 1 percent Rock outcrop.

Permeability is moderately slow. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is as low as 5 inches where depth to bedrock is 20 inches and many pebbles are present; it is as high as 11 inches where the ashy upper part of the soil is 35 inches thick and where bedrock is at a depth of 40 inches. The water-supplying capacity for natural vegetation is 12 to 17 inches.

This soil is used mainly for timber, grazing by livestock, and wildlife habitat. A few areas were subdivided for rural homesites. The soil mainly is too steep and the growing season is too short for nearly all cultivated crops.

This soil is well suited to the production of ponderosa pine. Timber can be harvested by tractor logging on slopes that range to about 30 percent, and by such methods as cable logging where slopes exceed 30 percent. Logging commonly is not done in winter and early in spring when the snow is deep. Windthrow is a problem because of the light weight of ash in which the tree roots anchor. Seedlings of ponderosa pone have a fair rate of survival if locally grown planting stock is used, and if the site has been adequately prepared.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 10 to 40 percent canopy cover in a moderately stocked mixed-age stand. Western juniper is a weak subordinate on this soil. The shrub layer is dominated by curlleaf mountainmahogany and antelope bitterbrush. Idaho fescue dominates the herbaceous understory. A variety of forbs occurs throughout the stand.

As the understory deteriorates, Idaho fescue and bitterbrush decrease and mountainmahogany and juniper increase. If the understory severely deteriorates, forbs and such less desirable shrubs as big sagebrush are prominent. In this condition, much ground is left bare and the hazard of soil erosion is high. Deterioration of the understory commonly results in dense clumps of pine reproduction.

Seedbed preparation and seeding are not practical because of the generally steep slopes. Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable for seeding. This community provides important winter food and cover for mule deer, which should be considered when planning management objectives.

Because of excessive slope and moderate depth to bedrock, this soil has important limitations for such community uses as homesites, small buildings, roads, lagoons, and landfills. Downslope movement and surfacing of effluent caused by slope steepness and irregularity, moderate soil depth, and moderately slow permeability in the buried soil can cause septic tank absorption fields to fail in a few years. Few homesites are on this soil.

This soil is in capability subclass VIe. .

56E-Maset coarse sandy loam, 12 to 35 percent south slopes. This well drained soil is on escarpments and volcanic hills. It formed in a thin mantle of ash on a loamy buried soil. The average slope is about 25 percent. Slopes predominantly face south. Elevation ranges from 4,200 to 5,500 feet. The average annual precipitation is 17 to 20 inches, the average annual air temperature is 41 to 44 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is very dark grayish brown, coarse sandy loam about 8 inches thick. The upper part of the underlying material is dark brown, gravelly coarse sandy loam that extends to a depth of about 21 inches. The lower part is a buried soil that is dark brown, very gravelly clay loam over weathered bedrock at a depth of 32 inches. The surface layer and upper part of the underlying material are mainly ash.

Included with this soil in mapping are about 5 percent areas of loamy soils overlying clay loam that is underlain by bedrock at a depth of 10 to 20 inches, about 5 percent areas where the surface of the soil is very stony, and about 1 percent areas of Rock outcrop. Also included are about 10 percent areas along the Sprague River that have outcroppings of bedrock.

Permeability is moderately slow. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is as low as 5 inches where depth to bedrock is 20 inches and many pebbles are present; it is as high as 11 inches where the ashy upper part of the soil is 35 inches thick and bedrock is at a depth of 40 inches. The water-supplying capacity for natural vegetation is 12 to 17 inches.

This soil is used mainly for timber, grazing by livestock, and wildlife habitat. Parts of some areas have been subdivided for rural homesites. The soil is too steep and the growing season is too short for nearly all cultivated crops.

This soil is well suited to the production of ponderosa pine. Timber can be harvested by tractor logging on slopes that range to about 30 percent and by such methods as cable logging where slopes exceed 30 percent. Logging commonly is not done in winter and early in spring when the snow is deep. Windthrow is a hazard because of light weight of the ash in which tree roots anchor. Seedlings of ponderosa pine have a fair rate of survival if locally grown planting stock is used and if the site has been adequately prepared.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 20 to 40 percent canopy cover in a moderately stocked mixed-age stand. The understory is dominated by Idaho fescue. A variety of perennial forbs occurs throughout the stand. The shrub layer is dominated by antelope bitterbrush.

As the understory deteriorates, forage bunchgrasses decrease. Bitterbrush increases for a time; then it decreases. If the understory severely deteriorates, annual weeds and such low value shrubs as big sagebrush and rabbitbrush dominate the understory. Deterioration of the understory commonly results in dense clumps of pine reproduction.

Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, hard fescue, and alfalfa are suitable for seeding. Mule deer commonly use this plant community during summer and fall for food and cover.

Because of excessive slope and moderate depth to bedrock, this soil has important limitations for such community uses as homesites, small buildings, roads, lagoons, and landfills. Downslope movement and surfacing of effluent caused by slope steepness and irregularity, moderate soil depth, and moderately slow permeability in the buried soil can cause septic tank absorption fields to fail in a few years. Few homesites are on this soil.

This soil is in capability subclass Vle.

57B-Merlin-Yancy association, gently sloping. These well drained soils are on lava benches and tablelands (fig. 13). They formed in material weathered mainly from tuff and basalt. On tablelands, slopes are mostly smooth but range from 1 to 8 percent and average about 2 percent. On rock benches, slopes average 5 percent. Elevation ranges from 4,400 to 5,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 20 to 50 days.

This association is about 60 percent Merlin extremely stony clay loam, 1 to 8 percent slopes, and about 30 percent Yancy clay loam, 1 to 8 percent slopes. The Merlin soil generally is on the upper part of the landscape. The Yancy soil has flatter and lower slopes. The proportions of Merlin and Yancy soils vary within the mapped areas. The proportion of Yancy soil is higher on tablelands than on lava benches. Included in the association are about 5 percent Royst soil, about 5 percent Ontko and Dilman soils, and 5 percent Rock outcrop on lava benches.

Typically, the Merlin soil has a surface layer of very dark brown, extremely stony clay loam about 4 inches thick. The subsoil extends to a depth of about 18 inches. The upper part is dark brown clay loam to a depth of about 12 inches; the lower part is dark brown clay to a depth of about 18 inches. Hard lava bedrock is at a depth of 18 inches. In places, the surface layer is only slightly stony or cobbly.

Permeability is very slow in the Merlin soil. Roots commonly penetrate to a depth of 10 to 20 inches.

Typically, the Yancy soil has a surface layer of very dark grayish brown clay loam about 2 inches thick. The subsoil extends to a depth of about 14 inches. The upper part is very dark grayish brown clay loam to a depth of about 6 inches, and the lower part is dominantly dark brown, gravelly clay to a depth of 14 inches. An indurated hardpan is at a depth of 14 inches. The surface layer is very stony or very cobbly in places.

Permeability is slow in the Yancy soil. Roots commonly penetrate to a depth of 12 to 20 inches.

Runoff is rapid, and the hazard of erosion is high on the Merlin and Yancy soils following spring runoff. Available water capacity is 1 to 4 inches. The water-supplying capacity for natural vegetation is 8 to 11 inches in each soil.

This association is used mainly for range and wildlife habitat. It is at a higher elevation than the water supplies, and little attempt has been made to irrigate or farm these soils.

The climax native plant community for the Merlin soil is dominated by Idaho fescue. Sandberg bluegrass is prominent. A variety of perennial forbs commonly occurs in small amounts. Low sagebrush is the dominant shrub.

If the range deteriorates, Idaho fescue decreases and Sandberg bluegrass, forbs, and low sagebrush increase. If the site severely deteriorates, Idaho fescue is nearly eliminated. In this condition, much ground is left bare and the hazard of soil erosion is high. Medusahead wildrye is a strong invader on this soil if the range is in poor condition.

Seedbed preparation and seeding of poor condition range are not practical on the Merlin soil because of the extremely stony surface condition. Low sagebrush in relative abundance is important browse for antelope and mule deer.

The climax native plant community on the Yancy soil is dominated by Idaho fescue, low sagebrush, and Sandberg bluegrass. A variety of perennial forbs occurs in small amounts. Antelope bitterbrush commonly is prominent.

If the range site deteriorates, Idaho fescue and bitterbrush decrease and low sagebrush and Sandberg bluegrass increase. If the site severely deteriorates, Idaho fescue is nearly eliminated, and much ground is left bare.

Seedbed preparation and seeding are needed on the Yancy soil if the range is in poor condition. Crested wheatgrass, intermediate wheatgrass, and pubescent wheatgrass are suitable for dryland seeding. Plants selected for seeding need to have good seedling vigor and be drought resistant.

Because of shallow depth to bedrock or an indurated hardpan and excessive stoniness on the Merlin soil, this association has important limitations for such community uses as homesites, small buildings, roads, landfill trenches, and lagoons. Shallow soil depth and very slow permeability in the subsoil can cause septic tank absorption fields to function poorly and fail in a few years. Failure of absorption fields have occurred on these soils. Several large areas of this association on Knott Tableland were subdivided for rural homesites, but only a few dwellings have been built.

This association is in capability subclass Vlls.

58A-Modoc fine sandy loam, 0 to 2 percent slopes. This well drained soil is on terraces in basins. It formed in lacustrine sediment weathered from tuff, diatomite, basalt, and a small amount of ash. An indurated hardpan is at a depth of 20 to 40 inches. Most areas of this soil were leveled for irrigation. Elevation ranges from 4,100 to 4,300 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown fine sandy loam about 12 inches thick. The subsoil extends to a depth of about 32 inches. The upper part, to a depth of about 23 inches, is dark brown sandy clay loam; the lower part, to a depth of about 32 inches, is dark yellowish brown clay loam. A calcareous hardpan that is indurated in the upper part is at a depth of 32 inches.

Included with this soil in mapping are about 10 percent areas of Harriman soil, about 15 percent areas of soils that have a surface layer of loam, and a large area of soil south of Miller Creek in Langell Valley which has a gravelly surface layer and gravelly or very gravelly subsoil. Also included are areas of slick spots and spots that are strongly alkaline which commonly make up about 1 percent of the map unit, but in a few places make up as much as 5 percent; and areas of soil where the water table usually is at a depth of 2 to 5 feet from May to October. The water table commonly is perched on the top of the hardpan following irrigation.

Permeability is moderately slow. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is as low as 2.5 inches where depth to the hardpan is about 20 inches and many pebbles are present; it is as high as 8 inches where depth to the hardpan is 40 inches and the soil has few pebbles.

This soil is used for irrigated crops, for example, Irish potatoes, barley, wheat, oats, alfalfa hay, cereal hay, and pasture. Oats commonly are grown for cereal hay. Kentucky bluegrass and alta fescue are suitable for pasture. Careful management of irrigation is needed to avoid waterlogging the rooting zone of potatoes. Overirrigation can also damage other crops.

This soil is suited to sprinkler, graded border, and furrow irrigation. Thin cuts are needed when leveling for borders and furrows to avoid exposing the infertile subsoil; deeper cuts expose the hardpan in many places. Sprinkler irrigation affords accurate control of soil moisture for potatoes and other crops and helps prevent raising the water table. Excessive irrigation can leach soluble plant nutrients, including nitrogen, below the root zone of crops. Deep drains are needed to lower the water table if excessive amounts of water are applied. Drains at borders and furrows can dispose of accumulated water and prevent waterlogging and crop damage.

A tillage pan forms readily in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent the formation of such a pan. Slick spots and persistent spots of alkali can be treated with sulfur or gypsum. Application of organic material helps to prevent formation of the hard crusts that develop on these spots and that hinder or prevent seedling emergence. Deep ripping to break up the hardpan may be successful if the hardpan is dry and not too thick to be shattered. If the hardpan is moist, it does not shatter well. Permanent pasture or a cropping system of 5 or 6 years of alfalfa hay, 2 years of potatoes, and 1 year of grain or cereal hay is well suited to this soil.

Because of the cemented hardpan, low strength of soil material, and the tendency of the subsoil to shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. Wetness also is a limitation for dwellings with basements and for shallow excavations. Moderate soil depth, moderately slow permeability in the subsoil, and wetness can cause septic tank absorption fields to function poorly or fail in a few years. Low strength limits the use of this soil material as roadfill and for dams and other embankments. Many rural homesites are on this soil.

This soil is in capability subclass Ills.

58B-Modoc fine sandy loam, 2 to 5 percent slopes. This well drained soil is on terraces near the edge of basins. It formed in lacustrine sediment weathered from tuff, diatomite, basalt, and a small amount of ash. An indurated hardpan is at a depth of 20 to 40 inches. Elevation ranges from 4,100 to 4,300 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown fine sandy loam about 12 inches thick. The subsoil extends to a depth of about 32 inches. The upper part, to a depth of about 23 inches, is dark brown sandy clay loam; the lower part, to a depth of about 32 inches, is dark yellowish brown clay loam. A calcareous hardpan that is indurated in the upper part is at a depth of 32 inches.

Included with this soil in mapping are about 10 percent areas of Harriman soil and 10 percent of Dodes soil that are about 2 acres in size.

Permeability is moderately slow. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is as low as 2.5 inches where depth to the hardpan is about 20 inches and many pebbles are present; it is as high as 8 inches where depth to the hardpan is 40 inches and the soil has few pebbles.

This soil is used for irrigated crops, for example, alfalfa hay, wheat, oats, barley, cereal hay, pasture, and Irish potatoes. Oats commonly are grown for cereal hay. Kentucky bluegrass and alta fescue are suitable for pasture. Careful management of irrigation is needed to avoid erosion and waterlogging the rooting zone of potatoes. Overirrigation can also damage other crops.

This soil is better suited to sprinkler irrigation than to other irrigation methods. Leveling for border and furrow irrigation requires deep cuts that expose the infertile subsoil and hardpan in many places. A few areas are irrigated by uncontrolled flooding. Some areas that are at a higher elevation than the water supplies are irrigated by pumping from canals and ditches. Rate of application of water needs to be carefully adjusted to prevent erosion and to avoid perching a water table above the hardpan. Excessive irrigation can leach soluble plant nutrients, including nitrogen, below the root zone of crops.

A tillage pan forms readily in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing help prevent formation of such a pan. Deep ripping can break up the hardpan if it is dry and not too thick to be broken through. If the hardpan is moist, it does not shatter well. Permanent pasture or a cropping system of 5 or 6 years of alfalfa hay and 2 years of grain or cereal hay is well suited to this soil.

Because of the cemented hardpan, the tendency of the subsoil to shrink and swell on drying and wetting, and low strength, this soil has important limitations for such community uses as homesites, small buildings, and roads. Moderate soil depth and moderately slow permeability in the subsoil can cause septic tank absorption fields to function poorly and fail in a few years. Low strength limits the use of the soil for roadfill, dams, and other embankments. Many rural homesites are on this soil.

This soil is in capability subclass IIIe.

58C-Modoc fine sandy loam, 5 to 15 percent slopes. This well drained soil is on terraces. It formed in lacustrine sediment weathered from tuff, diatomite, basalt, and a small amount of ash. An indurated hardpan is at a depth of 20 to 40 inches. Slopes mostly are short and convex. Elevation ranges from about 4,100 to 4,300 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

Typically, the surface layer is very dark brown fine sandy loam about 12 inches thick. The subsoil extends to a depth of about 32 inches. The upper part, to a depth of about 23 inches, is dark brown sandy clay loam; the lower part, to a depth of about 32 inches, is dark yellowish brown clay loam. A calcareous hardpan that is indurated in the upper part is at a depth of 32 inches.

Included with this soil in mapping are about 10 percent areas of Harriman soil and 10 percent of Calimus soil that are mostly less than 2 acres in size. Also included are about 5 percent areas of Dodes soil that are also mostly less than 2 acres in size.

Permeability is moderately slow. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is as low as 2.5 inches where depth to the hardpan is about 20 inches and many pebbles are present; it is as high as 8 inches where depth to the hardpan is about 40 inches and the soil has few pebbles.

This soil is used for irrigated crops, for example, alfalfa hay, wheat, oats, barley, cereal hay, and pasture. Oats commonly are grown for cereal hay. Irish potatoes are not commonly grown because of excessive slope. Kentucky bluegrass and alta fescue are suitable for pasture. Irrigation of grain and cereal hay crops needs to be managed to avoid erosion.

This soil is better suited to sprinkler irrigation than to other irrigation methods. Deep cuts that are needed to level the soil for border or furrow irrigation expose the hardpan and the infertile underlying layers below the hardpan in many places. A few areas of this soil are irrigated by uncontrolled flooding. Some areas that are at a higher elevation than the water supplies are irrigated by pumping from ditches and canals. Rate of application of water needs to be carefully adjusted to prevent excessive runoff and erosion and to avoid leaching soluble plant nutrients, including nitrogen, below the root zone of crops. Drainageways between some slopes need to be seeded to grass to prevent the formation of gullies.

A tillage pan forms readily in this soil, particularly if grain crops are grown in succession. Varying the depth of tillage and occasionally chiseling or deep plowing can help prevent formation of such a pan. Deep ripping can break up the hardpan if it is dry and not too thick. If the hardpan is moist, it does not shatter well. Permanent pasture, or a cropping system of 6 to 8 years of alfalfa hay and 1 year of grain or cereal hay is well suited to this soil.

Because of slope, the cemented hardpan, the tendency of the subsoil to shrink and swell on drying and wetting, and low strength, this soil has limitations for such community uses as homesites, small buildings, roads, and sanitary facilities. Moderate soil depth and moderately slow permeability in the subsoil can cause septic tank absorption fields in this soil to function poorly and fail in a few years. Low strength limits the use of this soil material for roadfill, dams, and other embankments. Many rural homesites are on this soil.

This soil is in capability subclass IVe.

59B-Nuss-Royst association, gently sloping. These well drained soils are on rock benches. They formed in material weathered from tuff, basalt, andesite, and a small amount of pumiceous ash. The Nuss soil commonly has a few widely scattered stones and boulders on the surface. The Royst soil is stony or bouldery in places and the average slope is about 3 percent. Slopes range from 1 to 8 percent. Elevation ranges from 4,300 to 5,300 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 20 to 50 days.

This association is about 65 percent Nuss loam, 1 to 8 percent slopes, and 20 percent Royst gravelly loam, 1 to 8 percent slopes. The proportions of these soils vary from one area to another. Included in the association are about 5 percent Ponina soil, about 5 percent a soil that has a loamy surface layer and a clayey subsoil and is underlain by bedrock at a depth of more than 60 inches, and about 5 percent spots of Rock outcrop and extremely bouldery areas.

Typically, the Nuss soil has a surface layer of dark brown loam about 8 inches thick. The subsoil is dark brown clay loam that extends to a depth of 13 inches. Tuffaceous bedrock is at a depth of 13 inches.

Permeability is moderate in the Nuss soil. Roots commonly penetrate to a depth of 12 to 20 inches. Runoff is rapid, and the hazard of erosion is high. Available water capacity is as low as 1.5 inches where depth to bedrock is 12 inches; it is as high as 4 inches where depth to bedrock is nearly 20 inches and the soil has few pebbles. Water-supplying capacity for natural vegetation is about 7 to 9 inches.

Typically, the Royst soil has a surface layer about 10 inches thick. The upper part is very dark grayish brown, stony loam about 3 inches thick, and the lower part is very dark grayish brown, very gravelly loam about 7 inches thick. The subsoil extends to a depth of about 34 inches. The upper part, to a depth of 24 inches, is dark brown, very gravelly clay loam; the lower part, to a depth of 34 inches, is dark reddish. brown, very gravelly clay. Tuffaceous bedrock is at a depth of 34 inches.

Permeability is slow in the Royst soil. Roots commonly penetrate to a depth of 25 to 40 inches. Runoff is rapid, and the hazard of erosion is high. Available water capacity is about 2.5 inches where depth to bedrock is 25 inches and the soil is most gravelly; it is about 6 inches where depth to bedrock is 40 inches and the soil is least gravelly. The water-supplying capacity for natural vegetation is 8 to 13 inches.

This association is used mainly for timber, grazing by livestock, and wildlife habitat.

This association is fairly suited to the production of ponderosa pine. Timber is easily harvested by tractor logging except when the snow is too deep in winter or the soil is too wet in spring. Windthrow is a severe hazard on the Nuss soil because of the shallow depth of the soil in which the tree roots anchor. It is less of a hazard on the Royst soil, where rooting depth is greater. Seedlings of ponderosa pine planted on the Nuss soil have a low rate of survival because of soil droughtiness, shallow rooting depth, and competition with other plants. Small numbers of white fir occur in stands with ponderosa pine at an elevation of more than 5,000 feet. Christmas trees are suited to these soils and are harvested in limited numbers at the higher elevations.

The climax native vegetation on these soils at an elevation of less than 5,000 feet is a ponderosa pine-western juniper woodland community. There is 10 to 40 percent canopy cover in a moderately stocked mixed-age stand. The shrub layer is dominated by curlleaf mountainmahogany and antelope bitterbrush. Idaho fescue and other grasses dominate the herbaceous understory. A variety of forbs occurs throughout the stand.

If the understory deteriorates, Idaho fescue and bitterbrush decrease and mountain mahogany and juniper increase. If it severely deteriorates, forbs and such less desirable shrubs as big sagebrush are prominent; much ground is left bare; and the hazard of erosion is high, especially on the shallow Nuss soil.

At an elevation of more than 5,000 feet, pine is dominant in the canopy and juniper is less prominent. The understory is dominantly curlleaf mountainmahogany, bitterbrush, squaw carpet, sedge, and numerous grasses.

Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable for seeding. These plant communities are a main source of food and cover in winter for mule deer.

Because of the shallow depth to bedrock, the Nuss soil has important limitations for such community uses as homesites, small buildings, roads, landfill trenches, and lagoons. Moderate soil depth and slow permeability in the subsoil of the Royst soil can cause septic tank absorption fields to function poorly and fail in a few years. The high tendency of the subsoil of the Royst soil to shrink and swell on drying and wetting limits the use of this soil material for foundations, embankments, and roadfill. Large areas of this association near Bly Mountain were subdivided for rural homesites, and many small dwellings that do not have domestic water and other sanitary facilities were built.

This association is in capability subclass Vle.

60E-Oatman very gravelly loam, 5 to 45 percent slopes. This well drained soil is on the eastern slope of Pelican Butte along the western side of Upper Klamath Lake. It formed in colluvium weathered from lava rocks including andesite, scoriaceous cinders, and basalt. The average slope is about 25 percent. Elevation ranges from 4,300 to 5,400 feet. The average annual precipitation is 30 to 35 inches, the average annual air temperature is 40 to 44 degrees F, and the frost-free season is less than 30 days.

Typically, the surface layer is dark brown, very gravelly loam about 17 inches thick. The subsoil is dark yellowish brown, very gravelly loam that extends to a depth of 34 inches. The substratum is dark brown, very gravelly loam to a depth of 60 inches or more.

Included with this soil in mapping are about 10 percent areas of Woodcock soil.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 4.5 to 9 inches. The water-supplying capacity for natural vegetation is 13 to 16 inches.

This soil is used mainly for timber, recreation, and wildlife habitat. It is well suited to production of timber from mixed stands of white fir, Douglas-fir, and ponderosa pine. Timber can be harvested by tractor logging on slopes that range to about 30 percent and by such methods as cable logging on slopes that exceed 30 percent. Logging commonly is not done in winter and spring when the snow is deep. Tree seedlings have a high rate of survival if locally grown planting stock is used and if the site is properly prepared. This soil is suitable for Christmas trees.

The climax native vegetation on this soil is a mixed conifer forest community. There is about 60 percent canopy cover in the aggregate in a moderately stocked mixed-age stand. White fir and Douglas-fir each with about 25 percent cover are dominant. Ponderosa pine with about 10 percent cover is prominent. Golden chinquapin dominates the shrub layer with about 10 percent foliar cover. Squawcarpet and snowbrush each with about 5 percent cover are prominent. The herbaceous understory is a sparse stand of shade-tolerant plants.

If the tree overstory is removed through logging, fire, or other disturbance, shrubs increase markedly. This condition can result in a temporary increase in grass and grasslike plants that provide considerable forage for a number of years. Forage production under forest cover generally is small.

Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Orchardgrass, timothy, hard fescue, and white clover are suitable for seeding. Mule deer use this plant community in summer and fall for food and cover.

Steepness of slope over most of the area is the main limitation for such community uses as homesites, roads, and sanitary facilities. Only a small proportion of the total area has slopes of less than 15 percent. Excessive rock fragments is a limitation if the soil is used for landfills, lagoons, and excavations. The soil can provide gravel in many locations although its use is limited by excessive fines. Presence of rock fragments that are larger than 6 inches in diameter severely limits the use of this soil material for embankments that impound water. This soil is near the recreational developments at Rocky Point and Harriman Lodge and in the path of a proposed ski-run and recreational development.

This soil is in capability subclass Vle.

61-Pit silty clay. This poorly drained, nearly level soil is on the diked and partially drained flood plain of the Lost River in Langell Valley, on Long and Round Lakes near the Cascade Mountains, and in scattered areas on Bryant and Stukel Mountains. It formed in clayey sediment weathered mainly from tuff and basalt. Elevation ranges from 4,140 to 4,260 feet. The average annual precipitation is 12 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is about 33 inches thick. The upper part is black silty clay about 6 inches thick, and the lower part is black clay about 27 inches thick. The substratum is very dark gray silty clay to a depth of 60 inches or more. It is mottled by lime at a depth of 33 to 42 inches. The soil is neutral to moderately alkaline in the upper part and moderately alkaline and calcareous in the lower part.

Included with this soil in mapping are about 5 percent areas of soils that are strongly alkaline or that are dispersed and have a slick appearance which are as much as 3 acres in size; about 10 percent areas of soils that are underlain at a depth below 30 inches by stratified layers of fine sand, sandy clay loam, and loam; and about 40 percent areas of soils that are noncalcareous throughout.

Permeability is slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 9 to 11 inches. In Langell Valley, a water table is at a depth of about 2 to 4 feet in this soil. Other areas in closed basins that lack outlets for drainage have a water table that mostly fluctuates at a depth of 0 to 4 feet. This soil is subject to frequent flooding unless it is protected by dikes.

This soil in Langell Valley is used mainly for irrigated pasture, oats, barley, and cereal hay. Oats mostly are grown for pasture. Wheat, alfalfa, and other crops do not grow well on this soil because the roots of these crops can be broken by internal soil movement caused by shrinking and swelling. In addition, alfalfa and wheat do not grow well on soils that are wet. Soils that are undrained, for example, those areas adjacent to Long and Round Lakes, mainly are used for wet meadow hay and pasture. Baltic rush, sedge, tufted hairgrass, and other wet meadow plants grow on these native meadows. Improved pastures of timothy, meadow foxtail, Reed canarygrass, and alta fescue are suited to this soil if proper seedbed preparation and water control measures are provided.

This soil is well suited to border irrigation. Sprinklers can be used, but they require careful design because of the slow rate of water intake. Cuts of 2 feet or more generally can be made in leveling without exposing layers of contrasting texture or fertility. Unleveled areas mostly are hummocky. Damage to crops can be caused by ponding and waterlogging if excessive water is applied in borders. The soil needs to be kept moist to prevent cracking and root damage. Light, frequent irrigation can avoid ponding or waterlogging and can prevent cracking. Periodic smoothing is needed to apply water evenly in borders because the surface can become uneven as a result of internal soil movement. Ponding and crop damage occur if water accumulates and stands in slight depressions.

Some drainage and water control are needed before crops can be grown. In Langell Valley, the Lost River has been diked to prevent flooding, and the soil is partially drained with ditches which carry excess water into the river channel. Other areas mostly lack drainage outlets. Drainage of these areas is not feasible without construction of reservoirs to hold runoff water, streams which empty into the basins, and pumping into the reservoirs to lower the water table. Drains need to be closely spaced because of the slow rate at which water moves laterally through the soil. Water can readily be added to this soil at a rate faster than it can be drained away, thereby raising the water table.

Tillage is difficult because of the clayey texture of this soil. The soil needs to be cultivated within a narrow range of moisture content when it is not too wet or too dry. Spring planting can be delayed considerably until the soil dries sufficiently. Alkali and dispersed or slick spots can be treated with gypsum or sulfur to hasten reduction of alkali and improve the structure of the surface layer. Permanent pasture is well suited to areas that are partially drained and protected from flooding. Oats grown for hay or grain are suited to this soil.

Because of wetness and the hazard of flooding, this soil has limitations for nearly all community uses. Low strength and internal soil movement caused by the high tendency of the soil to shrink and swell on drying and wetting are severe limitations for foundations and other structures. Low strength, potential frost action, and the tendency to shrink and swell also limit the use of this soil for roads, dams, and dikes. Roadbeds are elevated where roads cross this soil. Wetness and slow permeability can cause septic tank absorption fields to function poorly and fail in a few years. This soil is not used for homesites.

This soil is in capability subclass IIIw.

62-Poe loamy fine sand. This somewhat poorly drained soil is on low terraces. It formed in alluvial and lacustrine sediment weathered from tuff, basalt, diatomite, and ash. An indurated hardpan is at a depth of 20 to 40 inches. Nearly all areas of this soil were leveled for irrigation. Slopes are 0 to 2 percent. Elevation ranges from 4,050 to 4,150 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is about 16 inches thick. The upper part is very dark brown loamy fine sand about 3 inches thick, and the lower part is very dark brown or very dark grayish brown loamy sand about 13 inches thick. The upper part of the underlying material, to a depth of about 30 inches, is very dark grayish brown and dark grayish brown loamy sand. The lower part, at a depth of 30 inches, and ranging from about 4 to more than 30 inches in thickness, is indurated hardpan. The hardpan is underlain by loamy sand, loamy fine sand, and coarse sand to a depth of more than 60 inches. The soil ranges from moderately alkaline to very strongly alkaline. In most places, it is moderately alkaline.

Included with this soil in mapping are about 10 percent areas, mainly of Fordney soil, as much as 3 acres in size, which do not have a hardpan. Also included are about 5 percent areas of Laki and Henley soils and some areas of soils, mainly between the towns of Merrill and Malin, that predominantly are mildly alkaline.

Permeability is moderately rapid. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is very slow, and the hazard of water erosion is slight. There is a moderate hazard of wind erosion in spring when the surface layer dries and windspeed is high. Available water capacity is as low as 2 inches where depth to the hardpan is 20 inches; it is as high as 5.5 inches where depth to the hardpan is 40 inches. A water table is at a depth of 2 to 4 feet from May to September.

This soil is used for irrigated crops, for example, alfalfa hay, barley, wheat, oats, Irish potatoes, cereal hay, and pasture. Oats commonly are grown for cereal hay. Potatoes are grown only in drained and reclaimed areas where nearly all of the excess sodium and salt have been removed from the soil. Kentucky bluegrass and alta fescue are suitable for pasture. Alta fescue is better suited to the more strongly alkaline areas.

This soil is better suited to sprinkler irrigation than to other irrigation methods because of the high water intake rate. A large quantity of water must be applied to irrigate the lower end of borders and furrows. Excess water that is not used for crops perches a water table above the hardpan. Cuts of a foot or more can be made in leveling without exposing layers of contrasting texture, hardpan, alkalinity, and fertility. Rate of application of water needs to be carefully adjusted with sprinklers to supply proper moisture to crops without raising the water table. Overirrigation on this soil can leach plant nutrients, including nitrogen, below the root zone of crops, and can cause alkali to accumulate in the upper part of the soil. Much seepage is prevented by lining canals and ditches that cross this soil. Deep drains are needed to lower the water table below the root zone of crops and to permit reduction of alkali.

If the soil is adequately drained, leaching with irrigation water for several years reduces excess sodium and salt content in unreclaimed areas. Spots of alkali that resist leaching and slick or dispersed spots may respond to gypsum or sulfur. Deep ripping to break up the hardpan can hasten the reduction of alkali but is of doubtful value if the hardpan is too thick or too deep to be broken through, or if the hardpan is too moist to shatter.

Cropping systems that provide plant cover in spring when the surface layer is subject to blowing are well suited to this soil. Cropping systems and kinds of crops selected need to be determined by the amount of alkali in the soil. Alta fescue pasture is well suited to strongly alkaline areas. Barley grown for hay is suited to drained, strongly alkaline areas. Alfalfa hay, wheat, oats, and cereal hay can be grown in drained areas where the alkali content has been reduced. Potatoes are grown only in areas that are drained and free of alkali. A cropping system of 5 or 6 years of alfalfa hay, 1 or 2 years of potatoes, and 1 year of grain is suited to drained and reclaimed areas. Use of grain crop residue and conducting tillage and other farming operations at right angles to the prevailing wind reduce wind erosion.

Because of wetness and the indurated hardpan, this soil has important limitations for such community uses as homesites, small buildings, roads, and excavations. Seepage and contamination of ground water are serious hazards if lagoons and landfills are placed on this soil. Wetness and moderate soil depth can cause septic tank absorption fields to function poorly or fail. Many rural homesites are on this soil.

This soil is in capability subclass IIlw.

63-Poe fine sandy loam. This somewhat poorly drained soil is on low terraces. It formed in alluvial and lacustrine sediment weathered from tuff, basalt, diatomite, and ash. An indurated hardpan is at a depth of 20 to 40 inches. Nearly all areas of this soil were leveled for irrigation. Slopes are 0 to 2 percent. Elevation ranges from 4,050 to 4,150 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is very dark brown fine sandy loam about 9 inches thick. The upper part of the underlying material, to a depth of about 30 inches, is very dark grayish brown loamy sand. The lower part, at a depth of 30 inches, and ranging from about 4 to more than 30 inches in thickness, is indurated hardpan. The hardpan is underlain by loamy sand, loamy fine sand, and coarse sand to a depth of more than 60 inches. The soil ranges from moderately alkaline to very strongly alkaline. In most places, it is moderately alkaline.

Included with this soil in mapping are about 15 percent areas of Fordney soil that are mostly less than 3 acres in size which do not have a hardpan. Also included are about 30 percent places where the surface layer of the soil is loamy fine sand and a few areas of soil where the profile is fine sandy loam above the hardpan.

Permeability is moderately rapid. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is very slow, and the hazard of erosion is slight. The soil is subject to wind erosion in spring when the surface layer dries and windspeed is high. Available water capacity is as low as 2 inches where depth to the hardpan is 20 inches; it is as high as 5.5 inches where depth to the hardpan is 40 inches. A water table is at a depth of 2 to 4 feet in most areas from May to September.

This soil is used for irrigated crops, for example, alfalfa hay, barley, wheat, oats, Irish potatoes, cereal hay, and pasture. Oats commonly are grown for cereal hay. Potatoes are grown in soils that have been drained and are free of alkali. Kentucky bluegrass and alta fescue are suitable for pasture. Alta fescue is better suited to strongly alkaline areas than are other grasses.

This soil is suited to sprinkler, border, and furrow irrigation. Sprinklers are better suited than other irrigation methods because of the high rate of water intake. Lengths of run need to be short to avoid overirrigating the upper part of borders and furrows and perching a water table above the hardpan. Cuts of 1 foot or more can be made in leveling without exposing the hardpan or layers of contrasting texture and fertility. Rate of application of water needs to be carefully adjusted with sprinklers to supply proper moisture to crops without raising the water table. Overirrigation can readily leach plant nutrients, including nitrogen, below the root zone of crops, and can cause sodium and salt to accumulate in the upper part of the soil. Much seepage is prevented by lining canals and ditches that cross this soil. Deep drains are needed to lower the water table below the root zone of crops and to permit reduction of alkali.

If the soil is adequately drained, leaching with irrigation water for several years reduces excess sodium and salt content in unreclaimed areas. Remaining spots of alkali and slick or dispersed spots that resist leaching may respond to gypsum or sulfur. Deep ripping to break up the hardpan can hasten the reduction of alkali content but is of doubtful value if the hardpan is too thick or too deep to be broken through or if the hardpan is too moist to shatter.

Cropping systems that provide plant cover in spring when the surface layer is subject to blowing are well suited to this soil. Cropping systems and kinds of crops selected need to be determined by the amount of alkali in the soil. Alta fescue pasture is well suited to strongly alkaline areas. Barley grown for hay is suited to drained, strongly alkaline areas. Alfalfa hay, wheat, oats, and cereal hay can be grown in drained areas where the alkali content has been reduced. Potatoes are grown only in drained areas that are free of alkali. In these areas a cropping system of 5 or 6 years of alfalfa hay, 1 or 2 years of potatoes, and 1 year of grain is suitable. Use of grain crop residue and conducting tillage and other farming operations at right angles to the prevailing wind reduce wind erosion.

Because of wetness and the cemented hardpan, this soil has important limitations for such community uses as homesites, small buildings, roads, and excavations. Seepage and contamination of ground water are serious hazards if lagoons and landfills are placed on this soil. Wetness and moderate soil depth can cause septic tank absorption fields to function poorly or fail. Some areas of this soil have rural homesites.

This soil is in capability subclass IIIw.

64-Poe Variant loamy fine sand. This somewhat poorly drained soil is on low terraces. It formed in alluvial and lacustrine sediment weathered from tuff, basalt, diatomite, and ash. An indurated hardpan is at a depth of 10 to 20 inches. Slopes are 0 to 2 percent. Elevation ranges from 4,050 to 4,150 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is very dark grayish brown loamy fine sand about 4 inches thick. The upper part of the substratum is very dark grayish brown loamy fine sand that extends to a depth of 14 inches. The lower part is indurated hardpan to a depth of 18 inches and strongly cemented hardpan to a depth of 60 inches. The soil, including the hardpan, is strongly alkaline to very strongly alkaline.

Included with this soil in mapping are about 15 percent areas of Poe soil that have a hardpan at a depth of 20 to 30 inches and about 10 percent areas of soils where the hardpan is at a depth of 6 to 10 inches.

Permeability is moderately rapid, and the available water capacity is about 1 inch to 3 inches. Roots mostly penetrate to a depth of 10 to 20 inches. Runoff is very slow, and the hazard of water erosion is slight. There is a moderate hazard of wind erosion in spring when the surface layer dries and windspeed is high. A water table is at a depth of 1.5 to 4 feet from May to September.

This soil is used mainly for irrigated pasture. In a few areas small grain, mostly oats and barley are grown. Alta fescue is suitable for pasture.

This soil is better suited to sprinkler irrigation than to other irrigation methods because of the high water intake rate. Water that is applied in borders quickly saturates and waterlogs the soil by perching a water table above the hardpan. Many areas are irrigated with borders; however, if cuts of as much as 1 foot are made in leveling for borders, the hardpan can be exposed in many places. The rate and amount of water applied need to be carefully adjusted with sprinklers to supply moisture to crops without raising the water table. Much seepage can be prevented by lining canals and ditches that cross this soil. Deep drains are needed to lower the water table below the root zone of crops and to help reduce the alkali content.

Excess sodium and salt content can be reduced if the soil is adequately drained; the process is slow, however, because of shallow depth to hardpan, and because the hardpan itself may contain excess sodium. Ripping can hasten reclamation but is of doubtful value if the hardpan is too thick to be broken through or if it is too moist to shatter.

This soil is better suited to irrigated pasture than to other crops. In mildly alkaline or moderately alkaline areas, Kentucky bluegrass can be grown for pasture. Alta fescue is better suited to strongly alkaline areas. If grain crops are grown, use of crop residue reduces wind erosion.

Because of wetness and shallow depth to the indurated hardpan, this soil has important limitations for such community uses as homesites, small buildings, roads, and excavations. Seepage and contamination of ground water are serious hazards if lagoons and landfills are placed on this soil. Wetness and shallow soil depth can cause septic tank absorption fields to function poorly or fail over a period of years. The large area of this soil near the town of Malin is used for many rural homesites and a large commercial feedlot.

This soil is in capability subclass IVw.

65B-Ponina-Rock outcrop complex, 1 to 8 percent slopes. This complex consists of well drained, extremely stony Ponina soil, many small patches of Rock outcrop, and small mounds of lava tableland. The Ponina soil formed in material weathered from flow breccia, tuff, and basalt. The average slope is about 4 percent. Elevation ranges from 4,500 to 5,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 20 to 50 days.

This complex is about 80 percent Ponina extremely stony clay loam, 1 to 8 percent slopes; about 10 percent Rock outcrop and surface concentrations of stones that form strips, rings, and garlands; and about 5 percent Royst soil. The rest of the complex mainly is a nonstony soil on small scattered mounds.

Typically, the Ponina soil has a surface layer of dark brown, extremely stony clay loam about 3 inches thick. The subsoil is dark yellowish brown and dark brown clay that extends to a depth of about 18 inches. An indurated hardpan is at a depth of 18 inches.

Permeability is very slow in the Ponina soil. Roots commonly penetrate to a depth of 12 to 20 inches. Runoff is rapid following snowmelt in spring, and the hazard of erosion is high. Available water capacity is about 1.5 to 3.5 inches. The water-supplying capacity for natural vegetation is about 7 to 10 inches.

Patches of basaltic rock outcrop and stone strips, garlands, and rings are scattered over most areas of the complex. The stone strips on the more steeply sloping parts of the complex consist of rows of closely stacked basaltic stones and cobbles about 1 foot to 2 feet higher than the surface of the Ponina soil. They are 2 to 10 feet wide and about 50 to 500 feet or more long. The stone rings on the more nearly level parts of the complex form circular outlines of stones and cobbles that are about 25 to 75 feet in diameter. The garlands are similar to the stone rings but are elongated and rounded. They are on slopes of intermediate gradient and are between the slopes that have stone rings and the slopes that have stone stripes. Rimrock and concentrations of large basaltic boulders and blocks commonly are along one or more edges of the complex.

The circular mounds consist of areas that have a loam surface layer and clay subsoil. They are underlain by hardpan at a depth of about 30 to 40 inches. These mounds are about 2 to 5 feet higher than the surrounding Ponina soil surface and commonly are encircled by stone rings or garlands.

Included with this complex in mapping are areas of soils where the rock outcrop and stone rings, garlands, and stripes are almost absent; areas of soils that have only a few rings, garland, and stripes; and areas that have rings, garlands, and stripes on only a part of the surface.

This complex is used mostly for range and wildlife habitat. It is almost surrounded by forest, and the complex is an important influence in the overall management of these woodlands.

The climax native plant community for the Ponina soil in this complex is dominated by Idaho fescue. Sandberg bluegrass is prominent. A variety of perennial forbs commonly occurs in small amounts. Low sagebrush is the dominant shrub.

If the range site deteriorates, Idaho fescue decreases and Sandberg bluegrass, forbs, and low sagebrush increase. If the site severely deteriorates, Idaho fescue is nearly eliminated, much ground is left bare, and the hazard of soil erosion is high. Medusahead wildrye is a strong invader on this clayey soil if the range is in poor condition.

Seedbed preparation and seeding of poor condition range is not practical because of very stony and shallow soils. Where low sagebrush is plentiful, these soils provide important browse for antelope and mule deer.

Because of the extremely stony surface, rock outcrop, and shallow depth to the indurated hardpan, this complex has limitations for such community uses as homesites, small buildings, roads, and excavations and for such sanitary facilities as lagoons and landfills. Very slow permeability and shallow soil depth can cause septic tank absorption fields to function poorly and fail in a few years. This unit is not used for homesites or other structures.

This complex is in capability subclass VIls.

66F-Rock outcrop-Dehlinger complex, 35 to 65 percent slopes. This complex consists of many areas of lava bedrock outcrop, talus, and rock streams intermingled with areas of Dehlinger soil on escarpments that dominantly face south (fig. 14). The well drained Dehlinger soil formed in colluvium weathered mainly from basalt, tuff, and andesite. It has bedrock at a depth of more than 60 inches. The average slope is about 50 percent. Elevation ranges from 4,100 to 6,000 feet. The average annual precipitation is 12 to 16 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

This complex is about 45 percent Rock outcrop including rimrock, rock ledges, and thick accumulations of stones and boulders; and about 40 percent Dehlinger very stony loam, 35 to 65 percent slopes, on concave slopes that are mostly more than 1,000 feet in length. Most of the rest of the complex is very stony Lorella soil on convex slopes of about 15 to 35 percent that mostly are less than 500 feet in length.

Basaltic rimrock outlines the upper boundary of the complex. Numerous rock ledges and narrow rock streams are scattered over the face of the escarpment. Talus, consisting of thick accumulations of stones and boulders, mainly are on the lower half of the complex.

Typically, the surface layer of the Dehlinger soil is about 18 inches thick. The upper part is very dark brown, very stony loam about 6 inches thick, and the lower part is very dark grayish brown, extremely gravelly clay loam about 12 inches thick. The subsoil is dark brown or dark yellowish brown, extremely gravelly clay loam to a depth of 60 inches or more.

Permeability is moderate in the Dehlinger soil. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is as low as 4.5 inches where the subsoil is most gravelly; it is as high as 10 inches where the subsoil has only about 35 percent rock fragments. The water-supplying capacity for natural vegetation is 10 to 13 inches.

This complex is used mainly for wildlife habitat and range. Many areas also provide sources of gravel. All areas are too steep and rocky to be used for crops.

The climax native vegetation on this complex is a plant community dominated by western juniper with about 10 percent canopy cover. Bluebunch wheatgrass is the dominant understory grass. A variety of perennial forbs occur throughout the stand. Big sagebrush and antelope bitterbrush commonly occur. Shrubs generally are sparse except around rock talus and rock outcrops where they are prominent.

If the range site deteriorates, bluebunch wheatgrass and other desirable grasses decreases and big sagebrush increases and dominates the shrub understory. If the site severely deteriorates and there is a long history of recurring fire, juniper is nearly eliminated. In this condition rubber rabbitbrush and big sagebrush dominate the range site, much ground is left bare, and the hazard of soil erosion is high.

Seedbed preparation and seeding of poor condition range generally are not practical because of very stony soils and steep slopes. Wildlife values, especially food and cover needs for deer winter range, should be considered in planning management alternatives.

Because of steepness of slope and a high proportion of rock outcrop, this complex has important limitations for such community uses as roads, homesites, and small buildings and such sanitary facilities as lagoons and landfills. These soils are not used for homesites or buildings and only a few roads have been constructed on this unit.

This complex is in capability subclass VIIs.

67E-Rock outcrop-Nuss complex, 5 to 40 percent slopes. This complex consists of large areas of exposed bedrock interspersed with many small patches of Nuss soil, on tuff rings and maars. These patches mainly consist of domes and low rounded hills of tuffaceous bedrock (fig. 15). Most areas are roughly circular in shape. The well drained Nuss soil formed in material weathered from tuff and a small amount of pumiceous ash and is underlain by tuffaceous bedrock at a depth of 12 to 20 inches. North of Sprague River, however, the soil has a fairly high amount of ash. The average slope is about 15 percent. Elevation ranges from 4,200 to 5,000 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 20 to 50 days.

This complex is about 70 percent Rock outcrop and about 30 percent Nuss loam, 5 to 40 percent slopes. A few areas, for example, Devils Garden and Badlands, are about 90 percent Rock outcrop. In some areas the Nuss soil is about 30 percent pumiceous ash, and it is coarse sandy loam. Included in this map unit is about 10 percent Maset soil on the northern side of Sprague River.

Rock outcrop in many areas of this complex includes some large smooth areas of exposed tuffaceous bedrock. Many jagged cliffs, rock pedestals, and rough depressions commonly are near the eruptive centers of the rings and maars. Some areas, for example, Piute Rock, Badlands, and Buttes of the Gods, have mostly rough and broken topography.

Typically, the Nuss soil has a surface layer of dark brown loam about 8 inches thick. The subsoil is dark brown clay loam to a depth of about 13 inches. Tuffaceous bedrock is at a depth of 13 inches.

Permeability is moderate in the Nuss soil. Roots commonly penetrate to a depth of 12 to 20 inches. Runoff is rapid following snowmelt in spring, and the hazard of erosion is high. Available water capacity is as low as 1.5 inches where depth to bedrock is 12 inches and the soil has many pebbles; it is as high as 4 inches where depth to bedrock is nearly 20 inches and the soil has few pebbles. The water-supplying capacity for natural vegetation is 7 to 9 inches.

This complex mainly is used for wildlife habitat, range, and a small amount of timber. The large area on Antone Butte has been subdivided for rural homesites.

This complex is poorly suited to timber, partly because of large areas of Rock outcrop. Timber is easily harvested by tractor logging on the relatively smooth slopes except when the snow is deep in winter and spring. Tractor logging may be difficult or not feasible on the more rugged slopes. Windthrow is a severe hazard on the Nuss soil because of the shallow soil depth in which the tree roots anchor. Seedlings of ponderosa pine planted on the Nuss soil have a low rate of survival because of soil droughtiness, shallow rooting depth, and plant competition.

The climax native vegetation on the Nuss soil in this complex is a ponderosa pine woodland community. There is 10 to 40 percent canopy cover in a moderately stocked mixed-age stand. Western juniper is a weak subordinate. The shrub layer is dominated by curlleaf mountainmahogany and antelope bitterbrush. Idaho fescue dominates the herbaceous understory. A variety of forbs occurs throughout the stand.

If the understory deteriorates, Idaho fescue and bitterbrush decrease and mountainmahogany and juniper increase. If the understory severely deteriorates, forbs and such less desirable shrubs as big sagebrush are prominent. In this condition, much ground is left bare and the hazard of soil erosion is high. Deterioration of the understory commonly results in dense clumps of pine reproduction.

Seedbed preparation and seeding are not practical because of large areas of Rock outcrop and generally steep slopes. Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable on the Nuss soil to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable for seeding. This plant community provides important food and cover for mule deer, which should be considered when planning management objectives.

Because of large areas of Rock outcrop, shallow depth to bedrock in the Nuss soil, and generally steep slopes, this soil has important limitations for such community uses as homesites, small buildings, roads, landfill trenches, and lagoons. Shallow soil depth and excessive slope can cause septic tank absorption fields in the Nuss soil to function poorly and fail in a few years.

This complex is in capability class VIII.

68E-Royst stony loam, 5 to 40 percent north slopes. This well drained soil is on timbered escarpments that dominantly face north. It formed in very gravelly material weathered from tuff, basalt, andesite, and a small amount of pumiceous ash. Bedrock is at a depth of 25 to 40 inches. Elevation ranges from 4,300 to 5,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 10 inches thick. The upper part is very dark grayish brown, stony loam about 3 inches thick, and the lower part is very dark grayish brown, very gravelly loam about 7 inches thick. The subsoil extends to a depth of about 34 inches. The upper part, to a depth of 24 inches, is dark brown, very gravelly clay loam; and the lower part, to a depth of 34 inches, is dark reddish brown, very gravelly clay. Tuffaceous bedrock is at a depth of 34 inches.

Included with this soil in mapping are about 15 percent areas of Woodcock soil, about 5 percent areas of Nuss soil, and a few areas of soils which have only a few pebbles in the subsoil. Areas of Rock outcrop make up about 1 percent of the map unit.

Permeability is slow. Roots commonly penetrate to a depth of 25 to 40 inches. Runoff is rapid following snowmelt in spring in unprotected or bare areas, and the hazard of erosion is high. Available water capacity is as low as 2.5 inches where depth to bedrock is 25 inches and the soil is extremely gravelly; it is as high as 6 inches where depth to bedrock is 40 inches and the soil is less gravelly. The water-supplying capacity for natural vegetation is about 8 to 13 inches.

This soil is used mainly for timber, grazing by livestock, and wildlife habitat. Some areas have been subdivided for rural homesites. This soil is fairly suited to the production of ponderosa pine. Timber can be harvested by tractor logging with some difficulty on slopes that range to about 30 percent and by such other methods as cable logging where slopes exceed 30 percent. Windthrow is a moderate hazard because of the limited soil depth in which the tree roots anchor. Ponderosa pine seedlings have a good rate of survival if the site is properly prepared and if locally grown planting stock is used. White fir grows in mixed stands with ponderosa pine at an elevation of more than 5,000 feet.

The climax native vegetation on this soil at an elevation of less than 5,000 feet is a western juniper-ponderosa pine woodland community. There is 15 to 40 percent canopy cover in a moderately stocked mixed-age stand. The shrub layer is dominated by curlleaf mountainmahogany and antelope bitterbrush. Idaho fescue and other grasses dominate the herbaceous understory. A variety of forbs grows throughout the stand.

As the understory deteriorates, Idaho fescue and bitterbrush decrease and mountainmahogany and juniper increase. If the understory severely deteriorates, forbs and such less desirable shrubs as big sagebrush become prominent. In this condition, much ground is left bare and the hazard of erosion is high, especially on the shallow Nuss soil.

Pine is the dominant overstory species and juniper is subdominant in the canopy at an elevation of more than 5,000 feet. The understory is dominated by curlleaf mountainmahogany, bitterbrush, squaw carpet, sedge, and numerous grass species.

Seedbed preparation and seeding are not practical because of stony soil and generally steep slopes. Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and alfalfa are suitable for seeding. This plant community provides important winter food and cover for mule deer, and these values should be considered when planning management objectives.

Because of steepness of slope, somewhat limited depth to bedrock, and a high tendency of the subsoil is shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads and such sanitary facilities as lagoons and landfills. Slope steepness and irregularity, somewhat limited soil depth, and slow permeability in the subsoil can cause septic tank absorption fields to function poorly or fail in a few years. Although some areas of this soil have been subdivided in rural areas, few dwellings have been constructed.

This soil is in capability subclass Vle.

69E-Royst stony loam, 5 to 40 percent south slopes. This well drained soil is on timbered escarpments that predominantly face south. It formed in very gravelly material weathered from tuff, basalt, andesite, and a small amount of pumiceous ash. Bedrock is at a depth of 25 to 40 inches. The average slope is about 25 percent. Elevation ranges from 4,300 to 5,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 10 inches thick. The upper part is very dark grayish brown stony loam about 3 inches thick and the lower part is very dark grayish brown very gravelly loam about 7 inches thick. The subsoil extends to a depth of about 34 inches. The upper part, to a depth of 24 inches, is dark brown very gravelly clay loam; the lower part, to a depth of 34 inches, is dark reddish brown very gravelly clay. Tuffaceous bedrock is at a depth of 34 inches.

Included with this soil in mapping are about 10 percent areas of a very stony loam over very gravelly clay soil that is underlain by bedrock at a depth of 10 to 20 inches, about 5 percent areas of Nuss soil, and about 3 percent areas of Rock outcrop. The surface is very stony or extremely stony in places.

Permeability is slow. Roots commonly penetrate to a depth of 25 to 40 inches. Runoff is rapid following snowmelt in spring in unprotected or bare areas, and the hazard of erosion is high. Available water capacity is as low as 2.5 inches where depth to bedrock is 25 inches and the soil is extremely gravelly; it is as high as 6 inches where depth to bedrock is 40 inches and the soil is less gravelly. The water-supplying capacity for natural vegetation is 8 to 13 inches.

This soil is used mainly for timber, grazing by livestock, and wildlife habitat. It is fairly suited to the production of ponderosa pine. Timber can be harvested by tractor logging with some difficulty on slopes that range to about 30 percent and by such methods as cable logging where slopes exceed 30 percent. Windthrow is a moderate hazard because of the limited soil depth in which the tree roots anchor. Ponderosa pine seedlings have a fair rate of survival if the site is properly prepared and if locally grown planting stock is used.

The climax native vegetation on this soil is a plant community dominated by ponderosa pine and western juniper in variable amounts. The understory is dominated by bluebunch wheatgrass and antelope bitterbrush. A variety of perennial forbs occurs throughtout the stand.

If the range site deteriorates, bluebunch wheatgrass and bitterbrush decrease and young juniper and low value shrubs increase. Curlleaf mountainmahogany, a desirable shrub, increases for a time, then decreases. If the site severely deteriorates, juniper and a few scattered pine dominate the tree overstory. In this condition, much ground is left bare and the hazard of soil erosion is high.

Seedbed preparation and seeding of poor condition range are generally not practical because of stony soils. Following fire or other disturbances, broadcast seeding of intermediate or pubescent wheatgrass before rains settle the ash layer is advisable to improve forage production and to stabilize the soil. Wildlife values, especially food and cover needs for deer winter range, should be considered when planning management alternatives.

Because of steepness of slope, the somewhat limited depth to bedrock, and a high tendency of the subsoil is shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads and such sanitary facilities as lagoons and landfills. Slope steepness and irregularity, the somewhat limited soil depth, and slow permeability in the subsoil can cause septic tank absorption fields to function poorly or fail in a few years. Although some rural areas of this soil were subdivided, only a few dwellings have been built.

This soil is in capability subclass VIe.

70-Scherrard clay loam. This somewhat poorly drained, nearly level soil is on low terraces. It formed in alluvial and lacustrine sediment weathered mainly from tuff and diatomite. The soil has sufficient sodium to interfere with the growth of most crop plants. A strongly cemented hardpan is at a depth of 20 to 40 inches. Elevation ranges from 4,050 to 4,185 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is about 10 inches thick. The upper part is black clay loam about 5 inches thick, and the lower part is black silty clay about 5 inches thick. The subsoil that is black silty clay and has grayish brown lime segregations extends to a depth of 21 inches. The upper part of the substratum, to a depth of 33 inches, is a hardpan that is strongly cemented in the upper part and weakly cemented in the lower part. The substratum below the hardpan is dark grayish brown sandy loam to a depth of 60 inches or more. The surface layer, the subsoil, and the upper part of the hardpan are strongly alkaline; the lower part of the hardpan and the substratum are moderately alkaline.

Included with this soil in mapping are about 15 percent areas of Malin soil that are mainly less than 1 acre in size and about 15 percent areas of Lakeview soil in Poe Valley. The surface layer is only mildly alkaline or moderately alkaline over parts of many included areas.

Permeability is slow. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is very slow, and the hazard of water erosion is slight. Available water capacity is as low as 3.5 inches where depth to the hardpan is 20 inches; it is about 6 inches where depth to the hardpan is 30 inches; it is as high as 9 inches where depth to the hardpan is 40 inches. A water table is at a depth of about 0 to 3.5 feet from March to October and is mostly at a depth of about 2 or 3 feet. The water table results partly from irrigation, and overirrigation readily perches a water table above the hardpan. This soil also is subject to common flooding from March to May unless protected by dikes. Most areas along Lost and Klamath Rivers are diked.

This soil is used mainly for irrigated crops, for example, pasture, barley, and cereal hay. Alta fescue is suited to pasture. Oats and barley are grown for hay, but oats are not well suited to the most strongly alkaline areas. Barley can be grown for grain in drained areas if the soil is partially free of alkali. Irish potatoes are not grown on this soil because of the excessive sodium and salt content, clayey texture, and the high water table. Alfalfa is grown in some drained, partially reclaimed areas.

This soil is well suited to border irrigation. Furrows are not needed at present because of the kinds of crops grown. Sprinklers can be used for all crops, but the systems require careful design and control because of the low water intake rate. Some areas are subirrigated from the water table, but this can increase the amounts of sodium and salt that accumulate. Leveling for borders commonly requires only thin cuts; cuts of more than about 1.5 feet create shallow spots or expose the hardpan. Rate and amount of water applied need to be carefully adjusted to prevent raising the water table. Overirrigation can cause waterlogging and damage to crops. Slick or dispersed spots may need a longer wetting time to be adequately irrigated. Deep drains are needed for nearly all areas to lower the water table below the root zone of crops.

This soil is difficult to reclaim and few areas have been fully reclaimed. Leaching with irrigation water over a period of many years reduces excess sodium and salt content if the soil is adequately drained. Deep ripping to break up the hardpan hastens reclamation, but it must be done when the hardpan is dry and if it is not too thick to be broken through. If the hardpan is moist, it does not shatter well. Spots of alkali and slick and dispersed spots that resist leaching may respond to gypsum or sulfur. Application of organic material improves soil structure and increases the rate of water intake on these spots. Hard crusts tend to form on these spots that hinder or prevent seedling emergence. This soil is difficult to cultivate when it is too dry or too moist because of the clayey texture. Spring planting and cultivation can be delayed by wetness.

A long term cropping system that uses more alkali-sensitive crops is suited to this soil as soon as sodium and salt are reduced by leaching. In such a system, tall wheatgrass or alta fescue pasture can be grown for many years, followed by barley hay, and by alfalfa hay. After sufficient reduction of alkali, wheat and oats and other crops can be grown.

Because of wetness, the hazard of flooding, and a high tendency of the subsoil to shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. Flooding is also a hazard for lagoons, landfills, and excavations in unprotected areas. Wetness and slow permeability in the subsoil can cause septic tank absorption fields to function poorly or fail in a few years. A few areas of this soil have been used for homesites.

This soil is in capability subclass IVw.

71 B-Shanahan gravelly loamy coarse sand, 1 to 12 percent slopes. This somewhat excessively drained soil is on terraces. It formed in a moderately thick, air-laid mantle of pumiceous ash on a loamy buried soil. Slopes are smooth and mostly convex. Elevation ranges from 4,200 to 5,200 feet. The average annual precipitation is 18 to 25 inches, the average annual air temperature is 41 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 15 inches thick. The upper part is very dark grayish brown gravelly loamy coarse sand about 4 inches thick, and the lower part is dark brown gravelly coarse sand about 11 inches thick. The upper part of the underlying material is light olive brown and light yellowish brown coarse sand that extends to a depth of about 26 inches. Below this is a buried soil of dark brown fine sandy loam or extremely cobbly fine sandy loam to a depth of 60 inches or more. The surface layer and upper part of the underlying material are derived from pumiceous ash and cinders. The buried soil formed in material from tuff and diatomite.

Included with this soil in mapping are about 10 percent areas of soils near the upper end of slopes where depth to bedrock is about 18 to 40 inches and about 1 percent areas of Rock outcrop. The included soils have more than 35 percent cinders in many places.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is as low as 8.5 inches where thickness of the ashy part of the soil is about 14 inches and many rock fragments are in the buried soil; it is as high as 21 inches where the ashy part of the soil is 40 inches thick and a few rock fragments are in the buried soil. The water-supplying capacity for natural vegetation is 15 to 21 inches.

This soil is used mainly for timber, wildlife habitat, and grazing by livestock. It is well suited to the production of ponderosa pine and to the production of lodgepole pine which occurs in mixed stand with ponderosa pine. Timber is easily harvested by tractor logging except in winter and early in spring when the snow is deep. Windthrow is a severe hazard because of the light weight of the ashy material which makes up most of the soil in which the tree roots anchor. Seedlings of ponderosa pine can have a low rate of survival because of cold temperatures.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 10 to 35 percent canopy cover in a moderately stocked mixed-age stand. Lodgepole pine is subordinate. The understory is dominated by western needlegrass. Perennial forbs are sparse. Antelope bitterbrush dominates the shrub layer.

As the herbaceous understory deteriorates, bitterbrush increases. If the understory severely deteriorates or if the soil is disturbed, lodgepole pine increases and dominates the tree cover in places. In this condition, only remnants of the sparse stand of herbaceous plants remain and much ground is left bare under the trees.

If the tree overstory is removed through logging, fire, or other disturbances, such native plants as Ross sedge, needlegrass, and bottlebrush squirreltail increase and provide considerable forage for a number of years.

Seeding of introduced plants generally is not practical because of unmanageable soil conditions related to fertility, texture, and frost heaving. Herbaceous forage production under a typical tree overstory is small. Mule deer commonly use this plant community in summer and fall for food and cover.

This soil is suitable for such community uses as homesites, small buildings, roads, and septic tank absorption fields. Seepage is a severe limitation for lagoons and landfills. Seepage and contamination of ground water also are potential hazards for septic tank absorption fields, especially near streams or rivers. Small parks, a logging museum, and several camping facilities are on this soil north of the town of Chiloquin.

This soil is in capability subclass Vle.

71E-Shanahan gravelly loamy coarse sand, 12 to 45 percent north slopes. This somewhat excessively drained soil is on escarpments that predominantly face north. It formed in a moderately thick, air-laid mantle of pumiceous ash on a loamy buried soil. The average slope is about 25 percent, but some areas have slopes that range to as much as 60 percent. Elevation ranges from 4,200 to 5,200 feet. The average annual precipitation is 18 to 25 inches, the average annual air temperature is 41 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 15 inches thick. The upper part is very dark grayish brown, gravelly, loamy coarse sand about 4 inches thick, and the lower part is dark brown, gravelly coarse sand about 11 inches thick. The upper part of the underlying material is light olive brown and light yellowish brown coarse sand that extends to a depth of about 26 inches. Below this is a buried soil of dark brown fine sandy loam or extremely cobbly fine sandy loam to a depth of 60 inches or more. The surface layer and upper part of the underlying material are derived from pumiceous ash and cinders. The buried soil formed in material weathered mainly from tuff and basalt.

Included with this soil in mapping are about 10 percent narrow bands along the bottoms of slopes where depth to the loamy buried soil is more than 40 inches, many areas where the buried soil is very stony or cobbly, and many areas where the upper part of the soil has more than 35 percent cinders. Rock outcrop, including rimrock, makes up about 1 percent of the map unit.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is slow, and the hazard of erosion is slight except when the surface layer is frozen and water from melting snow cannot enter the soil. Under these conditions and in disturbed areas, runoff is rapid and the hazard of erosion is high. Available water capacity is as low as 8.5 inches where thickness of the ashy part of the soil is about 14 inches and many rock fragments are in the buried soil; it is as high as 21 inches where the ashy part of the soil is 40 inches thick and few rock fragments are in the buried soil. The water-supplying capacity for natural vegetation is 15 to 21 inches.

This soil is used mainly for timber, wildlife habitat, and grazing by livestock. It is well suited to the production of ponderosa pine. Timber can be harvested by tractor logging with some difficulty on slopes that range to about 30 percent and by such methods as cable logging where slopes exceed 30 percent. Windthrow is a severe hazard because of the light weight of the ashy material which makes up most of the soil in which the tree roots anchor. Seedlings of ponderosa pine have a high rate of survival if the site is properly prepared and if locally grown planting stock is used. White fir, Douglas-fir, and sugar pine commonly grow in the stand with ponderosa pine. This soil is suitable for Christmas trees.

The climax native vegetation on this soil is a mixed pine woodland community. There is about 25 percent canopy cover of ponderosa pine and sugar pine in a moderately stocked mixed-age stand. Lodgepole pine is subordinate. White fir is an understory that can be dominant at higher elevations. The shrub layer is dominated by snowbrush and greenleaf manzanita. The herbaceous layer is a sparse stand of shade-tolerant plants; Ross sedge is common in the openings.

If the tree overstory is removed through logging or other disturbances, snowbrush and greenleaf manzanita increase and sedge and other herbaceous plants decrease. This condition on the more gentle slopes, however, can result in a temporary increase in the native grasses and provide considerable forage for a number of years.

Seeding of introduced plants generally is not practical because of steep slopes and unmanageable soil conditions related to fertility, texture, and frost heaving. Herbaceous forage production under typical tree cover is small. Mule deer commonly use this plant community in summer and fall for food and cover.

Because of steepness of slope, this soil has important limitations for such community uses as homesites, small buildings, and roads and for such sanitary facilities as lagoons and landfills. Slope steepness and irregularity can cause septic tank absorption fields to fail as a result of effluent surfacing downslope. This soil is not used for homesites or other structures.

This soil is in capability subclass Vle.

72E-Shanahan gravelly loamy coarse sand, 12 to 45 percent south slopes. This somewhat excessively drained soil is on escarpments that predominantly face south. It formed in a moderately thick, air-laid mantle of pumiceous ash on a loamy buried soil. The average slope is about 25 percent, but some areas have slopes that range to as much as 60 percent. Elevation ranges from 4,200 to 5,200 feet. The average annual precipitation is 18 to 25 inches, the average annual air temperature is 41 to 45 degrees F, and the frost-free season to 10 to 50 days.

Typically, the surface layer is about 15 inches thick. The upper part is very dark grayish brown, gravelly, loamy coarse sand about 4 inches thick, and the lower part is dark brown, gravelly coarse sand about 11 inches thick. The upper part of the underlying material is light olive brown and light yellowish brown coarse sand that extends to a depth of about 26 inches. Below this is a buried soil of dark brown fine sandy loam and extremely cobbly fine sandy loam to a depth of 60 inches or more. The surface layer and upper part of the underlying material are derived from pumiceous ash and cinders. The buried soil formed in material weathered mainly from tuff and basalt.

Included with this soil in mapping are about 10 percent narrow bands along the bottoms of slopes where depth to the buried loamy soil is more than 40 inches; many areas where the ashy upper part of the soil has more than 35 percent cinders; and many areas where the buried soil is very stony, cobbly, or gravelly. Rock outcrop, including rimrock, makes up about 2 percent of the map unit.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is slow, and the hazard of erosion is slight except when the surface layer is frozen and water from melting snow cannot enter the soil. Under these conditions and in disturbed areas, runoff can be rapid and the hazard of erosion is high. Available water capacity is as low as 8.5 inches where thickness of the ashy part of the soil is 14 inches and many rock fragments are in the buried soil; it is as high as 21 inches where the ashy part of the soil is 40 inches thick and few rock fragments are in the buried soil. The water-supplying capacity for natural vegetation is 15 to 21 inches.

This soil is used mainly for timber, wildlife habitat, and grazing by livestock. It is well suited to the production of ponderosa pine. Timber can be harvested by tractor logging with some difficulty on slopes that range to about 30 percent, and by such methods as cable logging where slopes exceed 30 percent. Windthrow is a severe hazard because of the light weight of the ashy material which makes up most of the soil in which the tree roots anchor. Seedlings of ponderosa pine planted on this soil have a high rate of survival if the site is properly prepared and if locally grown planting stock is used.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is about 30 percent canopy cover of ponderosa pine in a moderately stocked mixed-age stand. Lodgepole pine, white fir, and sugar pine are subordinate. Bitterbrush, snowbrush, and greenleaf manzanita dominate the shrub layer. The herbaceous layer is a sparse stand of shade-tolerant plants. Western needlegrass is common in the openings.

If the tree overstory is removed through logging or other disturbance, shrub cover increases and needlegrass and other herbaceous plants decrease. This condition on the more gentle slopes can result in a temporary increase in the native grasses and provide considerable forage for a number of years.

Seeding of introduced plants generally is not practical because of steep slopes and unmanageable soil conditions related to fertility, texture, and frost heaving. Mule deer commonly use this community in summer and fall for food and cover.

Because of steepness of slope, this soil has important limitations for such community uses as homesites, small buildings, roads, and for such sanitary facilities as lagoons and landfills. Slope steepness and irregularity can cause septic tank absorption fields to fail as a result of effluent surfacing downslope. This soil is not used for homesites or other structures.

This soil is in capability subclass VIe.

73B-Steiger loamy coarse sand, 1 to 15 percent slopes. This somewhat excessively drained soil is on terraces and lava plains. It formed in very deep deposits of pumiceous ash and cinders that were reworked by water (fig. 16). The average slope is about 5 percent. Elevation ranges from 4,185 to 5,400 feet. The average annual precipitation is 20 to 35 inches, the average annual air temperature is 41 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 19 inches thick. The upper part is very dark brown loamy coarse sand about 4 inches thick, and the lower part is dark brown and dark yellowish brown, gravelly loamy coarse sand about 15 inches thick. The underlying material is yellowish brown and yellowish red, gravelly coarse sand that extends to a depth of 60 inches or more.

Included with this soil in mapping are about 20 percent areas of Maklak soil that are mostly less than 5 acres in size and about 5 percent narrow bands of Lapine soil.

Permeability is rapid. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 15 to 24 inches. The water-supplying capacity for natural vegetation is 17 to 19 inches.

This soil is used mainly for timber, wildlife habitat, and grazing by livestock. Use by livestock is very limited. This soil is very well suited to the production of ponderosa pine. Small numbers of lodgepole pine and, in places, white fir, Douglas-fir, and aspen are on this soil. Timber is easily harvested by tractor logging except in winter and spring when the snow is deep. Windthrow is a severe hazard because of the very light weight of the ashy material in which the tree roots anchor. Seedlings of ponderosa pine have a high rate of survival if the site is properly prepared and if locally grown planting stock is used. This soil is suitable for Christmas trees.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 15 to 45 percent canopy cover in a moderately stocked mixed-age stand. Lodgepole pine is subordinate and white fir may grow in small amounts. The understory is dominated by longstolon sedge. Such perennial forbs as strawberry are sparse. Snowbrush and greenleaf manzanita are prominent in the shrub layer.

If the understory deteriorates, sedge decreases and greenleaf manzanita and lodgepole pine increase. If there is severe deterioration or soil disturbance, lodgepole pine dominates the tree cover in places and much ground is left bare under the trees.

If the tree cover is removed through logging or other disturbances, a change in the microclimate occurs. Longstolon sedge and the native grasses temporarily increase and provide considerable forage for a number of years. Seeding of introduced plants generally is not practical because of unmanageable soil conditions related to fertility, texture, and frost heaving. Mule deer commonly use this plant community in fall for food and cover.

This soil is suitable for such community uses as homesites, small buildings, roads, and septic tank absorption fields. Moderate potential frost action is a limitation for foundations and roads. Seepage is a limitation for lagoons and sanitary landfills. Seepage and contamination of ground water are potential hazards in the operation of septic tank absorption fields, especially near streams and rivers. A few homesites have been built on this soil north of the town of Chiloquin. A small park and camping area also is on this soil.

This soil is in capability subclass Vls.

74B-Stukel-Capona loams, 2 to 15 percent slopes. These well drained soils are on rock benches around the edges of warmer basins. They formed in material weathered mainly from tuff and diatomite. Slopes mostly are short and convex. Elevation ranges from 4,100 to 4,700 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

This complex is about 55 percent Stukel loam, 2 to 15 percent slopes; 40 percent Caponz loam, 2 to 15 percent slopes; and about 5 percent small areas of smooth exposed bedrock.

Typically, the Stukel soil has a surface layer of dark brown loam about 7 inches thick. The underlying material is dark brown loam to a depth of about 17 inches. Tuffaceous bedrock is at a depth of 17 inches.

Permeability is moderate in the Stukel soil. Roots commonly penetrate to a depth of 10 to 20 inches. Runoff is rapid, and the hazard of erosion is high. Available water capacity is as low as 1.5 inches where depth to bedrock is 10 inches and the soil is gravelly; it is as high as 4 inches where depth to bedrock is 20 inches and the soil has no gravel. The water-supplying capacity for natural vegetation is 6 to 8 inches.

Typically, the Capona soil has a surface layer of very dark grayish brown loam about 11 inches thick. The subsoil is dark brown, gravelly sandy clay loam to a depth of about 25 inches. Tuffaceous or diatomaceous bedrock is at a depth of 25 inches.

Permeability is moderate in the Capona soil. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is medium, and the hazard of erosion is high. Available water capacity is as low as 3 inches where depth to bedrock is about 20 inches and the soil is gravelly; it is as high as 8.5 inches where depth to bedrock is 40 inches and where there are few pebbles. The water-supplying capacity for natural vegetation is 9 to 12 inches.

This complex is used mainly for range and for such irrigated crops as pasture, barley, wheat, oats, and cereal hay. Oats mainly are grown for cereal hay. Kentucky bluegrass and alta fescue are suitable for pasture. Alfalfa is grown for hay in some areas, but yields mostly are low.

This complex is better suited to sprinkler irrigation than to other irrigation methods because of shallow soil depth and irregular slopes. Cuts of more than 1 foot made in leveling commonly expose bedrock in many places on the Stukel soil. Rate of application of water needs to be carefully adjusted to prevent runoff and soil loss from erosion. Using crop residue and farming across the slope decrease runoff from irrigation and precipitation. Many areas of this complex are irrigated by uncontrolled flooding from ditches, but the hazard of erosion is particularly high. Because most areas of this complex are at a higher elevation than the water supplies, water must be pumped upslope to irrigate.

The climax native vegetation on this complex is a plant community dominated by western juniper with about 10 to 15 percent canopy cover. Bluebunch wheatgrass is the dominant understory grass. Idaho fescue and Sandberg bluegrass are prominent. A variety of perennial forbs occurs throughout the stand. Antelope bitterbrush and lesser amounts of big sagebrush are the dominant shrubs.

If the range site deteriorates, bluebunch wheatgrass, Idaho fescue, and bitterbrush decrease and forbs, big sagebrush, and juniper increase. If the site severely deteriorates, the bunchgrasses and such desirable shrubs as big sagebrush are nearly eliminated, much ground is left bare under the junipers, and the hazard of soil erosion is high. If deterioration is a result of recurring fire, juniper is nearly eliminated and low value shrubs dominate the range site.

Seedbed preparation and seeding are needed on this complex if the range is in poor condition. Crested wheatgrass and ladak alfalfa are suitable for dryland seeding. Wildlife values, especially food and cover needs for deer winter range, should be considered when planning management alternatives.

Because of shallow soil depth, this complex has important limitations for such community uses as homesites, small buildings, roads, lagoons, and landfill trenches. Shallow soil depth can cause septic tank absorption fields to function poorly or fail in a few years. Many areas of this complex are used for rural homesites.

These soils are in capability subclass IVe.

74D-Stukel-Capona loams, 15 to 25 percent slopes. These well drained soils are on rock benches near the edges of warmer basins. They formed in material weathered mainly from tuff and diatomite. Elevation ranges from 4,100 to 4,700 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 90 to 120 days.

This complex is about 65 percent Stukel loam, 15 to 25 percent slopes; about 20 percent Capona loam, 15 to 25 percent slopes; and about 15 percent small areas of Rock outcrop which mainly are smooth exposed bedrock.

Typically, the Stukel soil has a surface layer of dark brown loam about 7 inches thick. The underlying material is dark brown loam to a depth of about 17 inches. Tuffaceous bedrock is at a depth of 17 inches.

Permeability is moderate in the Stukel soil. Roots commonly penetrate to a depth of 10 to 20 inches. Runoff is rapid, and the hazard of erosion is high. Available water capacity is as low as 1.5 inches where depth to bedrock is 10 inches and the soil is gravelly; it is as high as 4 inches where depth to bedrock is 20 inches and the soil has no gravel. The water-supplying capacity for natural vegetation is 6 to 8 inches.

Typically, the Capona soil has a surface layer of very dark grayish brown loam about 11 inches thick. The subsoil is dark brown, gravelly sandy clay loam to a depth of about 25 inches. Tuffaceous or diatomaceous bedrock is at a depth of 25 inches.

Permeability is moderate in the Capona soil. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is medium, and the hazard of erosion is high. Available water capacity is as low as 3 inches where depth to bedrock is 20 inches and the soil is gravelly; it is as high as 8.5 inches where depth to bedrock is nearly 40 inches and where there are few pebbles. The water-supplying capacity for natural vegetation is 9 to 12 inches.

This complex is used mainly for range and wildlife habitat. Few areas are used for cultivated crops or are irrigated, and nearly all areas are at a higher elevation than the water supplies.

The climax native vegetation on this complex is a plant community dominated by western juniper with about 10 to 15 percent canopy cover. Bluebunch wheatgrass is the dominant understory grass. Idaho fescue and Sandberg bluegrass are prominent. A variety of perennial forbs occurs throughout the stand. Antelope bitterbrush and a less amount of big sagebrush are the dominant shrubs.

If the range site deteriorates, bluebunch wheatgrass, Idaho fescue, and bitterbrush decrease and forbs, big sagebrush, and juniper increase. If the site severely deteriorates, the bunchgrasses and such desirable shrubs as big sagebrush are nearly eliminated, much ground is left bare under the junipers, and the hazard of soil erosion is high. If deterioration is a result of recurring fire, juniper is nearly eliminated and low value shrubs dominate the range site.

Seedbed preparation and seeding are needed on this complex if the range is in poor condition. Crested wheatgrass and ladak alfalfa are suitable for dryland seeding. Wildlife values, especially food and cover needs for deer winter range, should be considered in planning management alternatives.

Because of shallow soil depth and excessive slope, this complex has important limitations for such community uses as homesites, small buildings, roads, lagoons, and landfill trenches. Shallow soil depth and excessive slope can cause septic tank absorption fields to function poorly or fail in a few years. Some areas of this complex are used for rural homesites.

These soils are in capability subclass Vle.

75-Sycan loamy sand. This excessively drained soil is on low terraces. It formed in very deep alluvial deposits of pumiceous ash. Slopes are 0 to 2 percent. Elevation ranges from 4,300 to 4,410 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 42 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is about 17 inches thick. The upper part is very dark grayish brown loamy sand about 5 inches thick, and the lower part is very dark grayish brown loamy coarse sand about 12 inches thick. The upper part of the substratum is dark brown loamy coarse sand and coarse sand that extends to a depth of about 50 inches; the lower part is brown and pale brown, mottled coarse sand to a depth of 60 inches or more.

Included with this soil in mapping are about 5 percent areas of Yonna soil mostly less than 1 acre in size that are strongly alkaline and about 10 percent areas of soils where the surface layer is calcareous and moderately alkaline. Also included are about 10 percent areas of soils where the substratum is silt loam or loam at a depth of 25 to 40 inches, and areas where a water table may be at a depth of 2 to 3 feet if the soil is overirrigated.

Permeability is rapid. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 12 to 24 inches. A water table generally is at a depth of 5 to 7 feet. The soil is subject to occasional brief flooding from March to May in periods of exceptionally high runoff.

This soil is used mainly for irrigated crops, for example, alfalfa hay, cereal hay, and pasture. Oats and rye are grown for pasture. Kentucky bluegrass and alta fescue are suitable for pasture. Dryland cereal hay and pasture grow in a few areas.

This soil is better suited to sprinkler irrigation than to other irrigation methods because of the high water intake rate. Excessive amounts of water are needed to irrigate the lower end of borders. Overirrigation can readily raise the water table and cause waterlogging and crop damage. Rate and amount of water applied need to be carefully adjusted to avoid leaching soluble plant nutrients, including nitrogen, below the root zone of crops. Much seepage is prevented by lining irrigation ditches that cross this soil. Permanent pasture and a cropping system of 6 to 8 years of alfalfa hay and 1 or 2 years of cereal hay are suitable for this soil.

Because of the hazard of flooding, this soil has important limitations for such community uses as homesites, small buildings, roads, and septic tank absorption fields. Seepage and contamination of ground water are serious hazards for lagoons and landfills. This soil is not used for homesites or other structures.

This soil is in capability subclass IVs.

76-Sycan Variant loamy coarse sand. This somewhat poorly drained soil is on low terraces. It formed in very deep alluvial deposits of pumiceous ash. The area below Knott Tableland is hummocky and uneven in spots. Slopes are 0 to 2 percent. Elevation is about 4,300 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 42 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loamy coarse sand about 21 inches thick. The upper part of the underlying material is dark grayish brown, mottled loamy coarse sand that extends to a depth of about 29 inches; the lower part is light gray and light brownish gray coarse sand to a depth of 60 inches or more. The surface layer is strongly alkaline in the upper part and moderately alkaline in the lower part, and the underlying material is neutral.

Included with this soil in mapping are about 10 percent areas of silt or silty clay loam where the substratum is at a depth below 30 inches and many areas of soils where the surface layer is mildly alkaline or moderately alkaline.

Permeability is rapid. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 12 to 24 inches. A water table which is at a depth of 1.5 to 4 feet from March to September results partly from uncontrolled flooding from artesian wells and irrigation. The soil is subject to occasional brief flooding from March to May in periods of exceptionally high runoff.

This soil is used mainly for irrigated crops, for example, alfalfa hay, cereal hay, and pasture. Oats and rye are grown for cereal hay. In most areas, alta fescue is better suited for pasture than other grasses because of the many strongly alkaline spots. Cereal hay also is grown in some dryland areas.

This soil is better suited to sprinkler irrigation than to other irrigation methods because of the high water intake rate. Excessive amounts of water are needed to irrigate the lower ends of borders. Overirrigation can readily raise the water table or perch it above the slowly permeable underlying layers, waterlog the soil, and cause crop damage. Rate and amount of water applied needs to be carefully adjusted to avoid leaching soluble plant nutrients, including nitrogen, below the root zone of crops. Much seepage is prevented by lining irrigation ditches that cross this soil. Deep drains are needed to lower the water table below the root zone of crops and to permit reduction of alkali by leaching.

Leaching with irrigation water over a period of a few years can reduce excess sodium and salt content if the water table has been lowered sufficiently by drainage. Remaining slick or dispersed spots can be treated with gypsum or sulfur. Hard crusts tend to form on these spots that can hinder or prevent seedling emergence. Application of organic material softens these crusts and improves soil structure in the surface layer. Alta fescue is suited to pasture in the more strongly' alkaline areas. Permanent pasture and a cropping system of 6 to 8 years of alfalfa hay and 1 or 2 years of cereal hay are suitable for drained and partially reclaimed areas.

Because of wetness and the hazard of flooding, this soil has important limitations for such community uses as homesites, small buildings, roads, and septic tank absorption fields. Seepage and contamination of ground water are serious hazards for lagoons and landfills. This soil is not used for homesites or other structures.

This soil is in capability subclass IVw.

77-Teeters silt loam. This poorly drained soil is on flood plains. It formed in silty sediment that consists mostly of diatoms, sponge spicules, ash, and related material. This soil has sufficient sodium to interfere with the growth of most crop plants. Elevation ranges from 4,085 to 4,140 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is about 16 inches thick. The upper part is black silt loam about 8 inches thick, and the lower part is very dark gray, mottled silt loam about 8 inches thick. The underlying material is dark gray, mottled silt and silt loam to a depth of 60 inches or more. The soil is strongly alkaline and calcareous to a depth of 36 inches and moderately alkaline to a depth of 60 inches.

Included with this soil in mapping are about 35 percent areas that are mostly less than 4 acres in size where the soils are only mildly alkaline or moderately alkaline throughout and about 10 percent small areas of Algoma soil.

Permeability is slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of water erosion is slight. There is a hazard of wind erosion in spring when the surface layer dries. Available water capacity is mostly about 15 inches. It is, however, as low as 5 inches in the most saline parts of this soil and as high as 30 inches in the least saline portions. A water table is at a depth of about 2 to 4 feet during most of the year. The soil is subject to frequent long periods of flooding from March to May unless protected by dikes and levees.

This soil is used mainly for irrigated pasture and barley. Oats are grown for cereal hay and grain in some partially reclaimed areas. Only saltgrass and alkali weeds grow in a few unreclaimed areas because of the high content of sodium and salt in the soil. Most fields have spotty, uneven growth caused by variability in alkali content, and this uneven growth causes considerable variation in crop yields. This soil is suitable for wheat, oats, alfalfa, and Irish potatoes if it is adequately drained and free of alkali.

This soil is suited to level border and sprinkler irrigation. Only thin cuts are commonly needed in leveling because of the nearly flat slope. Rate and amount of water applied need to be carefully adjusted to avoid raising the water table. Tail water at the ends of borders can be disposed of in drains to prevent crop damage from submergence and waterlogging. Many areas are subirrigated from the water table, but subirrigation increases the amount of sodium and salt in the soil. Deep drains are needed to lower the water table below the root zone of crops and to permit leaching of sodium and salt in all areas. Outlets for drains are lacking, and pumping is required for drainage. Although nearly all areas are protected by dikes or levees, there is a possible hazard of flooding because of poor suitability of soil material used in these structures.

Leaching with irrigation water over a period of many years can reduce excess sodium and salt content if the water table has been lowered sufficiently by drainage. Alkali and dispersed spots that resist leaching may respond to sulfur and gypsum. A long term cropping system that uses more alkali-sensitive crops is well suited to this soil as soon as the alkali content is reduced by leaching. In unreclaimed areas such a system could include tall wheatgrass or alta fescue pasture for many years followed by barley and alfalfa hay. When the soil is fully reclaimed, and if the growing season is 100 days or more, other small grain and possibly potatoes could be grown.

Because of wetness and the hazard of flooding, this soil has important limitations for such community uses as homesites, small buildings, roads, septic tank absorption fields, lagoons, and landfills. Low strength can also limit the use of this soil material for roads, homesites, and other structures. High potential frost action also limits the use of this soil material for roadfill. The material is poorly suited to construction of dikes because of high compressibility and low strength. Dike failure has occurred where this material was used in construction. This soil is not used for homesites.

This soil is in capability subclass IIlw.

78-Tulana silt loam. This poorly drained soil formed in sediment consisting mainly of diatoms, sponge spicules, ash, and related material. Slopes are 0 to 1 percent. Elevation is 4,080 to 4,140 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is black silt loam about 23 inches thick. It has been mixed by deep plowing. The upper part of the underlying material is grayish brown, mottled silt and dark brown, mottled, mucky silt that extends to a depth of 57 inches; the lower part is stratified very fine sandy loam, silt loam, and fine sand to a depth of 92 inches.

Included with this soil in mapping are about 5 percent areas of Algoma soil and 5 percent of Teeters soil, that are strongly alkaline; and about 5 percent areas of soils about 5 acres in size that have a surface layer of muck or peaty muck.

Permeability is moderately slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of water erosion is slight. There is a hazard of wind erosion in spring when the surface layer dries and windspeed is high. Available water capacity is about 23 to 33 inches. A water table is at a depth of about 4 to 6 feet from May to September and mostly is at a depth of below 4 feet. If the soil is overirrigated, however, the water table is as high as 2 feet. All areas of this soil are protected from flooding by dikes, but there is continuing possibility of dike failure because the material used in the dikes has low strength. Under natural conditions, the soil is inundated.

This soil is used mainly for irrigated crops, for example, barley, oats, cereal hay, pasture (fig. 17) and Irish potatoes. Barley mainly is grown for malt. Oats are grown for grain and cereal hay and the stubble and aftermath commonly are grazed by sheep. Alta fescue and Kentucky bluegrass are suitable for pasture. Potatoes mostly are grown for seed. Horseradish, sugar beets, and other crops also can be grown on this soil.

This soil is suited to sprinkler, furrow, and level border irrigation. Furrows are used where such row crops as potatoes are grown. Only thin cuts commonly are needed in leveling because of the nearly flat slope. The amount and rate of water needs to be carefully adjusted to avoid raising of the water table. Tail water at the ends of borders or furrows can be disposed of in drains to prevent crop damage from submergence and waterlogging. Deep drains are needed to lower the water table below the root zone of crops. Because outlets for these drains are lacking, a system of very deep interconnecting ditches and canals is used from which water is pumped to lower the water table. This soil can be subirrigated by raising the water table, but over a long period of time, subirrigation increases sodium and salt content in the soil.

Alkali spots on this soil may respond to gypsum or sulfur. Quack grass can be controlled for a period of up to 2 years by flooding for a period of about one year. Firm layers of light diatomaceous silt that mostly are at a depth of 1 foot to 3 feet in this soil and that impede root penetration can be broken up in many areas by plowing to a depth of 2 or 3 feet. Barley can be grown each year on this soil or in a long term cropping system together with pasture and 1 or 2 years of potatoes.

High potential for frost action and low strength are important limitations for such community uses as dwellings, small buildings, and roads. Excessive organic matter can cause a problem in the operation of lagoons, mainly from algae. Wetness and moderately slow permeability can cause septic tank absorption fields to function poorly or fail. Low strength, high compressibility, and excessive organic matter limit the use of soil material for dikes. Dike failure has occurred where this material was used in construction, and large areas were inundated in the December 1964 flood. This soil is not used for homesites.

This soil is in capability subclass Illw.

79-Tulana silt loam, sandy substratum. This poorly drained soil formed in sediment that consists mainly of diatoms, sponge spicules, ash, and related material. Slopes are 0 to 1 percent. Elevation is 4,080 to 4,140 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is black silt loam about 12 inches thick. The upper part of the underlying material is mottled, black silt that extends to a depth of about 22 inches; the middle part is mottled, very dark grayish brown, grayish brown, and dark grayish brown silt loam, silt, and very fine sandy loam to a depth of about 52 inches; and the lower part is mottled, gray loamy fine sand to a depth of 60 inches or more. Depth to the sandy substratum ranges from 40 to 60 inches.

Included with this soil in mapping are about 10 percent areas of Algoma soil that are mostly less than 3 acres in size and about 10 percent areas of soils where depth to the sandy substratum is more than 60 inches. The surface layer is mildly alkaline or moderately alkaline and weakly calcareous over about 15 percent of the map unit.

Permeability is moderately slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of water erosion is slight. There is a problem of wind erosion in spring when the surface layer dries and windspeed is high. Available water capacity is about 18 to 33 inches. A water table is at a depth of about 4 to 6 feet from May to September and mostly is at a depth of below 4 feet. If the soil is excessively irrigated, however, the water table is as high as 2 feet. All areas are protected from flooding by dikes, but there is a continuing possibility of dike failure because of the low strength of the material used in the dikes. Under natural conditions, the soil is inundated.

This soil is used mainly for irrigated crops, for example, barley, oats, cereal hay, pasture, and Irish potatoes. Barley mainly is grown for malt. Oats are grown for grain and cereal hay and the stubble and aftermath commonly are grazed by sheep. Alta fescue and Kentucky bluegrass are suitable for pasture. Potatoes mostly are grown for seed. Horseradish, sugar beets, and other crops are also suited to this soil.

This soil is suited to sprinkler, furrow, and level border irrigation. Furrows are used where such row crops as potatoes are grown. Only thin cuts commonly are needed in leveling because of the almost flat slopes. The amount and rate of water applied need to be carefully adjusted to avoid excessive irrigation and raising the water table. Fail water at the ends of borders or furrows can be disposed of in drains to prevent crop damage from submergence and waterlogging. Deep drains are needed to lower the water table below the root zone of crops; outlets for these drains are lacking, and a system of deep, interconnecting ditches and canals is used from which water is pumped to lower the water table. This soil is comparatively easy to drain because of the sandy underlying layers. It can be subirrigated by raising the water table but over a long period of time, subirrigation can increase the amounts of sodium and salt in the soil.

Alkali spots on this soil may respond to gypsum or sulfur. Quack grass can be controlled for a period of up to 2 years by flooding for a period of about one year. Firm layers of light colored diatomaceous silt that mostly are at a depth of 1 foot to 3 feet in this soil and that impede root penetration can be broken up in many areas by plowing to a depth of 2 or 3 feet. Barley can be grown each year on this soil or in a long term cropping system together with pasture and 1 or 2 years of potatoes.

Because of high potential frost action and low strength, this soil has important limitations for such community uses as homesites, small buildings, and roads. Excessive organic matter can cause a problem in the operation of lagoons, mainly because of algae. Wetness and moderately slow permeability can cause septic tank absorption fields to function poorly or fail. Low strength, high compressibility, and excessive organic matter limit the use of this soil material for dikes. Dike failure has occurred where this material was used in construction, and large areas were inundated in the December, 1964 flood. This soil is not used for homesites.

This soil is in capability subclass Illw.

80-Tutni coarse sandy loam. This moderately well drained soil is in swales, narrow valleys, and depressions on lava tablelands. It formed in water-deposited ash and cinders from dacitic pumice. Slopes are 0 to 3 percent. Elevation ranges from 4,185 to 4,800 feet. The average annual precipitation is 20 to 35 inches, the average annual air temperature is 41 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 19 inches thick. The upper part is very dark brown coarse sandy loam about 3 inches thick, and the lower part is dark brown loamy coarse sand about 16 inches thick. The underlying material is brown or reddish brown, mottled loamy coarse sand to a depth of 60 inches or more. A mat of conifer needles about 1/2 inch thick covers the surface.

Included with this soil in mapping are about 10 percent areas of Lapine and Steiger soils and about 15 percent areas of soils where the substratum is very gravelly.

Permeability is rapid. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 12 to 24 inches. A water table is at a depth of 3.5 to 5 feet. The water-supplying capacity for natural vegetation is 17 to 19 inches.

This soil is used for timber, wildlife habitat, and grazing by livestock. Use by livestock is limited. The soil is well suited to production of lodgepole pine. A small number of ponderosa pine also grow in many areas. Timber is easily harvested by tractor logging except in winter and spring when the snow is deep. Windthrow is a severe hazard because of the very light weight of the ashy material in which tree roots anchor. Seedlings of lodgepole pine have a high rate of survival if the site is properly prepared. Seedlings of ponderosa pine can have a low survival rate because of cold temperatures and wetness. This soil is suitable for Christmas trees.

The climax native vegetation on this soil is a lodgepole pine woodland community. There is 20 to 50 percent canopy cover in a moderately stocked mixed-age stand. Antelope bitterbrush dominates the shrub layer. In the understory, western needlegrass is prominent and perennial forbs are sparse.

If the tree overstory is removed through logging, fire, or other disturbance, needlegrass and bottlebrush squirreltail strongly increase and provide considerable forage for a number of years. Low value shrubs, for example, rabbitbrush, goldenweed, and wax currant increase if they were subordinate in the original stand.

Seeding of introduced plants generally is not practical because of unmanageable soil conditions related to fertility, texture, and frost heaving. Herbaceous forage production under a typical overstory of lodgepole pine is sparse. Mule deer commonly use this plant community in summer and fall for food and cover.

Because of wetness and potential frost action, this soil has limitations for such community uses as homesites, small buildings, and roads. Wetness can cause septic tank absorption fields to function poorly or fail. Seepage and contamination of ground water are serious hazards for lagoons and landfills. A small motel and a homesite have been built on this soil.

This soil is in capability subclass Vls.

81B-Woodcock gravelly loam, 1 to 5 percent slopes. This well drained soil is on glacial outwash plains. It formed in very gravelly glacial outwash derived mainly from andesite. Slopes mostly are smooth. Elevation ranges from 4,200 to 4,400 feet. The average annual precipitation is 18 to 25 inches, the average annual air temperature is 40 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface layer is about 10 inches thick. The upper part is very dark brown, gravelly loam about 2 inches thick, and the lower part is dark reddish brown, very gravelly loam about 8 inches thick. The subsoil extends to a depth of 48 inches. The upper part, to a depth of 17 inches, is dark reddish brown, extremely gravelly loam; the lower part, to a depth of 48 inches, is dark reddish brown, extremely gravelly clay loam. The substratum is dark reddish brown, extremely cobbly loam to a depth of 60 inches or more. A mat of conifer needles about 1/2 inch thick covers the mineral soil surface.

Included with this soil in mapping are about 1 percent narrow streamers of poorly drained, very deep soils that mostly have wet meadow plants and some aspen on them. Also included are about 5 percent areas on the lower edge of the map unit, that are moderately well drained and have a water table at a depth of 4 to 6 feet; these areas are transitional to marshy areas along Upper Klamath Lake.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is slow, and the hazard of erosion is slight. Available water capacity is 4 to 7 inches. The water-supplying capacity for natural vegetation is 11 to 16 inches.

This soil is used mainly for timber, wildlife habitat, and grazing by livestock. It is well suited to ponderosa pine. Small numbers of grand fir, Douglas-fir, and incense cedar also occur in the stand. Timber is easily harvested by tractor logging except in winter when the snow is deep. Windthrow is not a particular hazard because the large content of heavy rock fragments in the soil anchors the tree roots. Seedlings of ponderosa pine have a high rate of survival if the site is properly prepared for planting and if locally grown planting stock is used. The limited number of Christmas trees produced naturally on this soil could be increased by planting seedlings of Douglas-fir and grand fir in openings.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 20 to 40 percent canopy cover in a moderately stocked mixed-age stand. The understory is dominated by greenleaf manzanita, squawcarpet, and Ross sedge. A variety of perennial forbs occurs throughout the stand in small amounts.

If the understory deteriorates, Ross sedge decreases and forbs and less desirable grasses, for example, bottlebrush squirreltail increase. If the understory severely deteriorates, shrubs strongly increase and clumps of dense pine reproductions are established.

Following logging, fire, or other disturbances, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Intermediate wheatgrass, hard fescue, and alfalfa are suitable for seeding. Mule deer commonly use this plant community in summer and fall for food and cover.

Potential frost action is the main limitation for such community uses as homesites, small buildings, and roads. The large amount of rock fragments limits the use of this soil material if lagoons and landfill trenches are constructed or if this material is used as cover for area landfills. Septic tank absorption fields can function with minimal difficulty for many years.

This soil is in capability subclass Vle.

81E-Woodcock association, north. These well drained soils are on escarpments of fault block mountains that have north exposures. They formed in extremely gravelly colluvium weathered from andesite, basalt, and a small amount of cinders and ash. Slopes are concave, mostly face north, and mainly are 500 to more than 3,000 feet long. The average slope is about 20 percent.

This association is about 60 percent Woodcock stony loam, 5 to 40 percent slopes; and about 25 percent Woodcock stony loam, 5 to 40 percent slopes, cool.

The Woodcock stony loam, 5 to 40 percent slopes, is on the lower part of the landscape. Elevation ranges from 4,200 to 5,900 feet. The average annual precipitation is about 18 to 22 inches, the average annual air temperature is about 43 to 45 degrees F, and the frost-free season is about 35 to 50 days.

Typically, the Woodcock stony loam, 5 to 40 percent slopes, has a surface layer about 10 inches thick. The upper part is very dark brown, stony loam about 2 inches thick and the lower part is dark reddish brown, very gravelly loam about 8 inches thick. The subsoil extends to a depth of about 48 inches. The upper part, to a depth of about 17 inches, is dark reddish brown, extremely gravelly loam; the lower part, to a depth of 48 inches, is dark reddish brown, extremely gravelly clay loam. The substratum is dark reddish brown, extremely cobbly loam to a depth of 60 inches or more. A mat of conifer needles about 1/2 inch thick overlies the mineral soil surface layer.

The Woodcock stony loam, 5 to 40 percent slopes, cool, is on the upper part of the landscape. Elevation ranges from 5,900 to 6,500 feet. The average annual precipitation is about 22 to 25 inches, the average annual air temperature is about 42 to 43 degrees F, and the frost-free season is about 10 to 35 days. This soil is similar to Woodcock stony loam, 5 to 40 percent slopes, except temperatures are cooler, precipitation is greater, and the frost-free season is shorter.

Included with these soils in mapping are about 4 percent areas of soils that are slightly gravelly throughout. Also included are about 10 percent areas of Royst soil that are mostly less than 5 acres in size, and about 1 percent areas of Rock outcrop. Narrow bands of Lobert or Bly soil, about 50 to 200 feet wide, are along the bottoms of slopes in some areas where elevation is less than 4,400 feet.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 4 to 7 inches. The water-supplying capacity for natural vegetation is 11 to 16 inches.

These soils are used mainly for timber, wildlife habitat, and grazing. They are well suited to production of ponderosa pine (fig. 18). White fir, grand fir, Douglas-fir, and sugar pine (fig. 19) also occur in the stand and become more prominent as elevation and precipitation increase. Timber can be harvested by tractor logging on slopes that range to about 30 percent and by such methods as cable logging where slopes exceed 30 percent. Windthrow is not a particular hazard because large numbers of heavy rock fragments anchor the tree roots. Seedlings of ponderosa pine have a high rate of survival if the site is properly prepared and locally grown planting stock is used. Christmas trees are produced naturally in abundance on many disturbed and logged-over areas of this soil.

The climax native vegetation on Woodcock stony loam, 5 to 40 percent slopes, is a mixed fir-ponderosa pine forest community. Douglas-fir with about 40 percent canopy cover is subordinate. The understory is dominated by about 10 percent snowbrush, and a variety of shade-tolerant grasses and forbs occur in small amounts. If the overstory is removed through fire or logging, snowbrush is a strong increaser.

The climax native vegetation on Woodcock stony loam, 5 to 40 percent slopes, cool, is a white fir forest community with a 50 percent canopy cover. The understory is dominated by about 20 percent golden chinquapin or common snowberry and about 10 percent sedge. Forage production under forest cover generally is small; cutover or burned areas, however, produce considerable forage for a number of years.

Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Orchardgrasses, timothy, hard fescue, and white clover are suitable for seeding. Mule deer use these plant communities in summer and fall for food and cover.

Steepness of slope is an important limitation for such community uses as dwellings, small buildings, and roads. Large amounts of rock fragments also are a limitation where soil is used for landfill trenches or where soil material is used for cover on area landfills. Stones and the potential for seepage severely limit use of material for embankments that impound water. Steepness and irregularity of slope cause effluent to surface downslope and septic tank absorption fields may function poorly or fail. Many dwellings have been built on this unit in Klamath Falls along the south end of Upper Klamath Lake, and on Bly Mountain.

This association is in capability subclass Vle.

82E-Woodcock association, south. These well drained soils are on escarpments of fault block mountains that have south exposures. They formed in extremely gravelly colluvium weathered from andesite, basalt, and small amounts of cinders and ash. Slopes are concave, mostly face south, and are mainly 500 to more than 3,000 feet long. The average slope is about 20 percent.

This association is about 45 percent Woodcock stony loam, 5 to 40 percent slopes, and about 20 percent Woodcock stony loam, 5 to 40 percent slopes, cool.

Woodcock stony loam, 5 to 40 percent slopes, is on the lower part of the landscape. Elevation ranges from about 4,200 to 5,900 feet. The average annual precipitation is 18 to 23 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is about 35 to 50 days.

Typically, Woodcock stony loam, 5 to 40 percent slopes, has a surface layer about 10 inches thick. The upper part is very dark brown, stony loam about 2 inches thick and the lower part is dark reddish brown, very gravelly loam about 8 inches thick. The subsoil extends to a depth of about 48 inches. The upper part, to a depth of about 17 inches, is dark reddish brown, extremely gravelly loam; the lower part, to a depth of about 48 inches, is dark reddish brown, extremely gravelly clay loam. The substratum is dark reddish brown, extremely cobbly loam to a depth of 60 inches or more. A mat of conifer needles about 1/2 inch thick overlies the mineral soil surface.

Woodcock stony loam, 5 to 40 percent slopes, cool, is on the upper part of the landscape. Elevation ranges from about 5,900 to 6,500 feet. The average annual precipitation is about 23 to 25 inches, the annual air temperature is 40 to 43 degrees F, and the frost-free season is about 10 to 35 days. This soil is similar to Woodcock stony loam, 5 to 40 percent slopes, except temperatures are cooler, precipitation is greater, and the frost-free season is shorter.

Included with these soils in mapping are about 5 percent areas of soils that are only slightly gravelly throughout. Also included are about 15 percent areas of Royst soil that are mostly less than 5 acres in size; about 10 percent areas of a very stony loamy soil that is underlain by bedrock at a depth of 10 to 20 inches; and about 5 percent areas of Rock outcrop, including rimrock.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 4 to 7 inches. The water-supplying capacity for natural vegetation is about 11 to 16 inches.

These soils are used mainly for timber, wildlife habitat, and grazing by livestock. They are well suited to the production of ponderosa pine. White fir, grand fir, Douglas-fir, and sugar pine also occur in the stand on the south slope of Doak Mountain and in other places where precipitation exceeds about 20 inches. Timber is harvested by tractor logging on slopes that range to about 30 percent and by such methods as cable logging where slopes exceed 30 percent. Windthrow is not a hazard because large numbers of heavy rock fragments anchor the tree roots. Seedlings of ponderosa pine planted on these soils have a fair rate of survival if the site is properly prepared and if locally grown planting stock is used.

The climax native vegetation on Woodcock stony loam, 5 to 40 percent slopes, is ponderosa pine with 20 to 40 percent canopy cover. The understory is dominated by greenleaf manzanita, squawcarpet, and sedge. If woodland communities deteriorate, shrubs and pine reproduction strongly increase. The climax native vegetation of Woodcock stony loam, 5 to 40 percent slopes, cool, is white fir and ponderosa pine forest. White fir with about 50 percent canopy cover is dominant. Ponderosa pine with about 20 percent canopy cover is subordinate. The understory is a sparse stand of about 5 percent snowbrush, about 10 percent sedge, and a few shade-tolerant forbs. Forage production under forest cover generally is small; cutover or burned areas, however, produce considerable forage for a number of years.

Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Woodcock stony loam, 5 to 40 percent slopes, is suited to seedings of intermediate wheatgrass, hard fescue, and alfalfa; Woodcock stony loam, 5 to 40 percent slopes, cool, is suited to such plants as orchardgrass, timothy, hard fescue, and white cover. Mule deer use these plant communities in summer and fall for food and cover.

Because of steep slopes, these soils have important limitations for such community uses as homesites, small buildings, and roads. Large amounts of rock fragments limit excavation of landfill trenches or material for cover on area landfills. Stones and potential seepage severely limit the use of this soil for dams. Steepness and irregularity of slope cause effluent to surface downslope and can cause septic tank absorption fields to function poorly or fail. Many homesites are on these soils on Bly Mountain.

This association is in capability subclass Vle.

83F-Woodcock-Rock outcrop complex, 40 to 60 percent north slopes. This complex consists of well drained Woodcock association, north; Rock outcrop; and stone accumulations. It is on steep escarpments that have north exposures. The Woodcock soil formed in very gravelly colluvium weathered from andesite, basalt, and a small amount of cinders and ash. The average slope is about 50 percent, but some slopes are as much as 70 percent.

This complex is about 70 percent Woodcock association, north, and 30 percent Rock outcrop. Rock outcrop includes rimrock, rock streams, talus, and exposed bedrock on slopes.

The Woodcock association, north, is about 50 percent Woodcock stony loam, 5 to 40 percent slopes; and about 20 percent Woodcock stony loam, 5 to 40 percent slopes, cool.

The Woodcock stony loam, 5 to 40 percent slopes, is on the lower part of the landscape. Elevation ranges from about 4,200 to 5,200 feet. The average annual precipitation is about 18 to 22 inches, the average annual air temperature is about 43 to 45 degrees F, and the frost-free season is 35 to 50 days.

Typically, Woodcock stony loam, 5 to 40 percent slopes, has a surface layer about 10 inches thick. The upper part is very dark brown, stony loam about 2 inches thick and the lower part is dark reddish brown, very gravelly loam about 8 inches thick. The subsoil extends to a depth of about 48 inches. The upper part, to a depth of about 17 inches, is dark reddish brown, extremely gravelly loam; the lower part, to a depth of about 48 inches, is dark reddish brown, extremely gravelly clay loam. The substratum is dark reddish brown, extremely cobbly loam to a depth of 60 inches or more. A mat of conifer needles about 1/2 inch thick overlies the mineral surface soil.

Woodcock stony loam, 5 to 40 percent slopes, cool, is on the upper part of the landscape. Elevation ranges from about 5,900 to 6,500 feet. The average annual precipitation is about 22 to 35 inches, the average annual air temperature is about 40 to 43 degrees F, and the frost-free season is about 10 to 35 days. This soil is similar to Woodcock stony loam, 5 to 40 percent slopes, except temperatures are cooler, precipitation is greater, and the frost-free season is shorter.

Permeability of the Woodcock soils is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. The water-supplying capacity for natural vegetation is 11 to 16 inches.

Lava rimrock commonly outlines the upper boundary of the complex, and many areas of Rock outcrop are in it. Rock streams, or narrow drainages filled with large stones, are scattered over the surface of the complex; and talus accumulates along the base of some of the steeper escarpments, forming almost continuous bands. Rock fragments in the talus range from about 1 foot to more than 5 feet in diameter.

This complex is used mainly for timber and wildlife habitat. It is fairly well suited to the production of ponderosa pine. White fir, grand fir, and Douglas-fir also grow on this complex and are more prominent at higher elevations that have more precipitation. This complex is too steep and rugged in almost all areas to safely harvest timber by tractor logging. Such methods as cable logging can be used. Windthrow is not a particular hazard because the large number of heavy rock fragments in the soil of this complex anchors tree roots. Planting tree seedlings is not practical because of the difficulty in site preparation. Seedlings of ponderosa pine, however, have a good rate of survival if they are properly planted and if locally grown planting stock is used. Christmas trees can be produced in abundance in disturbed and logged areas, but harvesting is difficult.

The climax native vegetation on Woodcock stony loam, 5 to 40 percent slopes, is mixed fir-ponderosa pine forest community. Douglas-fir with about 40 percent canopy cover is dominant. White fir and ponderosa pine, each with about 15 percent cover, are subordinate. The understory is dominated by about 10 percent snowbrush. A variety of shade-tolerant grasses and forbs occurs in small amounts. If the overstory is removed through fire or logging, snowbrush strongly increases. The climax native vegetation on Woodcock stony loam, 5 to 40 percent slopes, cool, is white fir forest community with about 50 percent canopy cover. The understory is dominated by about 20 percent golden chinquapin or common snowberry and about 10 percent sedge. Forage production under forest cover generally is small; however, cutover or burned areas produce considerable forage for a number of years.

Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Orchardgrass, timothy, hard fescue, and white clover are suitable for seeding. Mule deer use these plant communities in summer and fall for food and cover.

Because of steep slopes and Rock outcrop over almost all parts of this complex, these soils have important limitations for such community uses as homesites, small buildings, and roads. The high amount of rock fragments limits the use of the soil material for landfill trenches or for cover in area landfills. Use of the material for dams also is severely limited because of stones and potential seepage. Slope steepness and irregularity cause effluent to surface downslope, and can cause septic tank absorption fields in the Woodcock soils to function poorly or fail. This complex is not used for homesites or other buildings.

The Woodcock soils are in capability subclass Vlls.

84F-Woodcock-Rock outcrop complex, 40 to 60 percent south slopes. This complex consists of well drained Woodcock association, south; Rock outcrop; and stone accumulations. It is on steep escarpments that have south exposures. The Woodcock soils formed in extremely gravelly colluvium weathered from andesite, basalt, and a small amount of cinders and ash. The average slope is about 50 percent, but some slopes are as much as 70 percent.

This complex is about 60 percent Woodcock association, south slopes, and 30 percent Rock outcrop. Rock outcrop includes rimrock, rock streams, talus, and exposed bedrock on slopes.

The Woodcock association, south, is about 40 percent Woodcock stony loam, 5 to 40 percent slopes; and about 20 percent Woodcock stony loam, 5 to 40 percent slopes, cool.

The Woodcock stony loam, 5 to 40 percent slopes, is on the lower part of the landscape. Elevation ranges from about 4,200 to 5,900 feet. The average annual precipitation is about 18 to 23 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is about 35 to 50 days.

Typically, Woodcock stony loam, 5 to 40 percent slopes, has a surface layer about 10 inches thick. The upper part is very dark brown, stony loam about 2 inches thick and the lower part is dark reddish brown, very gravelly loam about 8 inches thick. The subsoil extends to a depth of about 48 inches. The upper part, to a depth of about 17 inches, is dark reddish brown, extremely gravelly loam; the lower part, to a depth of about 48 inches, is dark reddish brown, extremely gravelly clay loam. The substratum is dark reddish brown, extremely cobbly loam to a depth of 60 inches or more. A mat of conifer needles about 1/2 inch thick overlies the mineral soil surface.

Woodcock stony loam, 5 to 40 percent slopes, cool, is on the upper part of the landscape. Elevation ranges from about 5,900 to 6,500 feet. The average annual precipitation is about 22 to 25 inches, the average annual air temperature is about 40 to 43 degrees F, and the frost-free season is about 10 to 35 days. This soil is similar to Woodcock stony loam, 5 to 40 percent slopes, except temperatures are cooler, precipitation is greater, and the frost-free season is shorter.

Included with these soils in mapping are about 10 percent areas of Royst soil.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is 4 to 7 inches. The water-supplying capacity for natural vegetation is 11 to 16 inches.

Lava rimrock commonly outlines the upper boundary of the complex, and many areas of Rock outcrop are scattered over it. Rock streams, or narrow drainages filled with stones, also are scattered over the complex, and talus accumulates along the base of the steeper escarpments forming almost continuous bands. Rock fragments in the talus range from about 1 foot to more than 5 feet in diameter.

This complex is used mainly for timber and wildlife habitat. It is fairly well suited to the production of ponderosa pine. White fir, grand fir, and Douglas-fir occur in the stand at higher elevations, mostly in small amounts. This complex is too steep and rugged in almost all areas to safely harvest timber by tractor logging. Such methods as cable logging can be used. Windthrow is not a particular hazard because the large amount of heavy rock fragments in the soils anchor tree roots. Planting tree seedlings on this complex is not practical because of the difficulty in site preparation. Seedlings of ponderosa pine, however, have a fair rate of survival if they are properly planted and if locally grown planting stock is used.

The climax native vegetation for Woodcock stony loam, 5 to 40 percent slopes, is a ponderosa pine woodland community with 20 to 40 percent canopy cover. The understory is dominated by greenleaf manzanita, squawcarpet, and sedge. If woodland communities deteriorate, shrubs and pine reproduction strongly increase. The climax native vegetation for Woodcock stony loam, 5 to 40 percent slopes, cool, is a white fir and ponderosa pine forest community. White fir is dominant with about 50 percent canopy cover, and ponderosa pine is subordinate with about 20 percent cover. The understory is a sparse stand of about 5 percent snowbrush, about 10 percent sedge, and a few shade-tolerant forbs. The forage production underforest cover generally is small; however, cutover or burned areas produce considerable forage for a number of years.

Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Woodcock stony loam, 5 to 40 percent slopes, is suitable for seeding of intermediate wheatgrass, hard fescue, and alfalfa. Woodcock stony loam, 5 to 40 percent slopes, cool, is suitable for seeding such plants as orchardgrass, timothy, hard fescue, and white clover. Mule deer use these plant communities in summer and fall for food and cover.

Because of steep slopes and Rock outcrop, this complex has important limitations for community uses as homesites, small buildings, and roads. The high amount of rock fragments also limits the use of the soil material for landfill trenches or for cover for area landfills. Use of the material for dams is severely limited by stones and potential seepage. Slope steepness and irregularity can result in effluent surfacing downslope, and can cause septic tank absorption fields in the Woodcock soils to function poorly or fail. This complex is not used for homesites or other buildings.

The Woodcock soils are in capability subclass Vlls.

85-Xerofluvents, nearly level. This moderately well drained, nearly level soil is on flood plains adjacent to the Klamath River between the town of Keno and the Weyerhaeuser Mill. It formed in sandy and silty alluvium hydraulically dredged from the bed of the Klamath River in 1971 and spread as a slurry over the flood plains. The surface is slightly uneven. Elevation is about 4,090 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is dark grayish brown loamy fine sand about 7 inches thick. The upper part of the underlying material is dark grayish brown loamy fine sand that extends to a depth of about 21 inches; and the middle part is very dark gray silt foam to a depth of about 44 inches; and the lower part is soil buried by dredge material that is black, diatomaceous silt to a depth of 60 inches or more. The surface layer and upper and middle parts of the underlying material were dredged from the riverbed.

The soil profile ranges from loamy fine sand to silt. It is highly variable in texture depending on the depth and texture of the dredged material which has been placed over the diatomaceous silt. Depth to the diatomaceous silt ranges from 20 to more than 60 inches. In some areas the soil primarily is silt loam that has as much as 60 percent diatomaceous rock fragments below a depth of 10 inches. In about 10 percent of the map unit, the surface layer is silt loam.

Runoff is very slow, and the hazard of water erosion is slight. There is a moderate hazard of wind erosion in spring when the surface layer dries, windspeed is high, and surface texture is coarser than very fine sandy loam. A water table is at a depth of 3.5 to 5 feet from March to October. The soil is subject to rare flooding.

This soil is used mainly for irrigated crops, for example, alfalfa hay, oats, cereal hay, and pasture. Oats and rye are grown for cereal hay. Crops are difficult to establish, and yields are low. The main soil problem is lack of fertility. The upper part of this soil is highly leached and strongly acid material from the riverbed. If fertilizer needs are determined and adequate fertilizer applied, this soil should be well suited to all crops grown in the survey area, including Irish potatoes.

This soil is better suited to sprinkler irrigation than to other irrigation methods because of the rapid rate of water intake. Large quantities of water are needed to irrigate the lower ends of borders and furrows, and excess water that is not used by crops could raise the water table. Comparatively deep cuts can be made in leveling without exposing layers of contrasting fertility. Rate of application of water needs to be carefully adjusted with sprinklers to supply proper moisture to crops without raising of water table. Overirrigation on this soil can readily leach plant nutrients, including nitrogen, below the root zone of crops. Much seepage is prevented by lining canals and ditches that cross this soil.

Because of wetness and the hazard of flooding, this soil has important limitations for such community uses as homesites, small buildings, and roads. Wetness is a severe limitation for dwellings with basements; this limitation, however, is not so great for those dwellings that do not have basements, for small buildings, and for roads. Wetness can cause septic tank absorption fields to function poorly or fail. Seepage is a hazard for lagoons and landfills. This soil is not used for homesites.

This soil is in capability subclass IIIe.

86C-Yainax loam, 1 to 15 percent slopes. This well drained soil is on rock benches. It formed in material weathered mainly from diatomite. Bedrock is at a depth of 20 to 40 inches. Slopes are short and mostly convex. Elevation ranges from 4,300 to 4,700 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 5 inches thick. The subsurface layer is dark grayish brown loam about 9 inches thick. The subsoil is dark brown and brown clay loam that extends to a depth of about 31 inches. Very pale brown and yellowish brown soft bedrock made up of subangular pieces of diatomite is at a depth of 31 inches. A mat of loose pine needles overlies the mineral soil surface.

Included with this soil in mapping are about 5 percent areas of Royst soil on tops of low knolls and ridges that are mostly less than 1 acre in size, about 10 percent areas of Nuss soil similar in size and position to Royst soil, and about 5 percent narrow bands of Bly soil on concave lower slopes.

Permeability is moderately slow. Roots commonly penetrate to a depth of 20 to 40 inches. Runoff is medium, and the hazard of erosion is moderate. Available water capacity is as low as 3 inches where depth to bedrock is 20 inches and the soil has many rock fragments; it is as high as 7 inches where depth to bedrock is 40 inches and few rock fragments are present. The water-supplying capacity for natural vegetation is 9 to 14 inches.

This soil is used mainly for timber, grazing by livestock, and wildlife habitat. A few areas, mainly near Bug Butte, are used for irrigated crops, for example, alfalfa hay, cereal hay, and pasture. Oats and rye are grown for cereal hay. Kentucky bluegrass and alta fescue are suitable for pasture.

This soil is better suited to sprinkler irrigation than to other irrigation methods. Because of slope irregularity, leveling for borders requires deep cuts that expose bedrock in many places. The rate and amount of water applied need to be carefully adjusted to prevent runoff and erosion from irrigation, particularly if cereal hay is grown. Use of crop residue improves soil structure and tilth in the surface layer and reduces spring runoff and erosion. Permanent pasture or a cropping system of 6 to 8 years of alfalfa hay and 2 years of cereal hay are suited to this soil.

This soil is well suited to the production of ponderosa pine. Timber can easily be harvested by tractor logging except in winter and spring when the snow is deep. Seedlings of ponderosa pine planted on this soil have a fair rate of survival if the site is properly prepared and if locally grown planting stock is used. Thinning is needed for good stand development because natural regeneration produces dense stands of seedlings and young trees.

The climax native vegetation on this soil is a ponderosa pine woodland community. There is 20 to 40 percent canopy cover in a moderately stocked mixed-age stand. The understory is dominated by Idaho fescue. A variety of perennial forbs occurs throughout the stand. The shrub layer is dominated by antelope bitterbrush.

If the understory deteriorates, forage bunchgrasses decrease. Bitterbrush increases for a time; then it decreases. If the understory severely deteriorates, annual weeds and such low value shrubs as big sagebrush and rabbitbrush dominate the understory. Deterioration of the understory commonly results in dense clumps of pine reproduction.

Land clearing for irrigated or dryland crop production is suitable on the more gently sloping parts of this soil. Following fire or logging, broadcast seeding before fall rains settle the seedbed is advisable to stabilize disturbed soil areas. Crested wheatgrass, intermediate wheatgrass, hard fescue, and alfalfa are suitable for dryland seeding. Mule deer commonly use this plant community in summer and fall for food and cover.

Because of moderate depth to bedrock and low strength of the soil material, this soil has important limitations for such community uses as homesites, small buildings, and roads. Depth to bedrock is also a limitation if lagoons and landfill trenches are planned. Because of limited thickness, the soil is a poor source of material for roadfill and daily cover for area landfills. Soil depth and moderately slow permeability can cause septic tank absorption fields to function poorly or fail in a few years. Some dwellings have been built on this soil near Bug Butte.

This soil is in capability subclass IVe.

87A-Yancy clay loam, 0 to 2 percent slopes. This well drained soil is on terraces. It formed in gravelly sediment weathered from basalt, tuff, and felsite. An indurated hardpan is at a depth of 12 to 20 inches. Elevation ranges from 4,200 to 4,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown clay loam about 2 inches thick. The subsoil extends to a depth of 14 inches. The upper part is very dark grayish brown clay loam to a depth of about 6 inches and the lower part is dominantly dark brown, gravelly clay to a depth of about 14 inches. An indurated hardpan is at a depth of 14 inches.

Included with this soil in mapping are about 10 percent areas of soils where depth to the hardpan is about 20 to 38 inches and about 10 percent areas where depth to the hardpan is about 6 to 12 inches. About 3 percent of the map unit has a stony or cobbly surface layer.

Permeability is slow. Roots commonly penetrate to a depth of 12 to 20 inches. Runoff is rapid following snowmelt in spring. The hazard of erosion is high, especially on long slopes that have considerable runoff. Available water capacity is as low as 1 inch where depth to the hardpan is about 12 inches and the soil is gravelly; it is as high as 4 inches where depth to hardpan is 20 inches and few pebbles are present. The water-supplying capacity for natural vegetation is 8 to 11 inches.

This soil is used mainly for range and wildlife habitat. Alfalfa hay, cereal hay, and pasture are grown in a few areas that are irrigated from wells. Oats and rye are grown for cereal hay. Alta fescue and Kentucky bluegrass are suitable for pasture. Yields of crops are low because of shallow soil depth and the short growing season. Most areas are at a higher elevation than the water supplies.

This soil is suited to sprinkler and border irrigation. The amount and rate of water applied needs to be carefully adjusted to prevent runoff and erosion. Cuts of more than about 1 foot made in leveling for borders create very shallow spots or expose the hardpan in many places. Only areas that have very smooth and even slopes before leveling can be successfully leveled and irrigated by borders. Overirrigation perches a water table above the hardpan and causes crop damage by waterlogging. Ditches at the ends of borders can dispose of accumulated water and prevent crop damage from submergence and waterlogging.

The hardpan in this soil can be ripped only with considerable difficulty and mostly it is too thick to be broken through. Ripping increases rooting depth and available water capacity to a limited extent. Permanent pasture or cropping system of 6 to 8 years of alfalfa hay and 1 or 2 years of cereal hay are suited to this soil.

The climax native plant community on this soil is dominated by Idaho fescue, low sagebrush, and Sandberg bluegrass. A variety of perennial forbs occurs in small amounts. Antelope bitterbrush commonly occurs in large amounts.

If the range site deteriorates, Idaho fescue and bitterbrush decreases and low sagebrush and Sandberg bluegrass increases. If the site severely deteriorates, Idaho fescue is nearly eliminated and much ground is left bare.

If the range site is in poor condition, seedbed preparation and seeding are needed. Crested wheatgrass, intermediate wheatgrass, and pubescent wheatgrass are suitable for dryland seeding. Plants selected for seeding should have good seedling vigor and be drought resistant.

Because of shallow depth to indurated hardpan and the high tendency of the subsoil to shrink and swell on drying and wetting, this soil has important limitation for such community uses as homesites, small buildings, and roads. The hardpan also is a limitation if lagoons, landfill trenches, or shallow excavations are constructed. The soil material below the hardpan commonly is very gravelly and, in places, provides a source of gravel. Gravel pits are in this soil near the town of Sprague River. Shallow soil depth and slow permeability can cause septic tank absorption fields to function poorly and fail in a few years. Numerous failures of septic tank systems have occurred on this soil.

This soil is in capability subclass IVs.

87B-Yancy clay loam, 2 to 8 percent slopes. This well drained soil is on terraces. It formed in gravelly sediment weathered from basalt, tuff, and felsite. An indurated hardpan is at a depth of 12 to 20 inches. Slopes are mostly uneven or undulating. Elevation ranges from 4,200 to 4,500 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 43 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown clay loam about 2 inches thick. The subsoil extends to a depth of 14 inches. The upper part is very dark grayish brown clay loam to a depth of about 6 inches, and the lower part is dominantly dark brown., gravelly clay to a depth of about 14 inches. An indurated hardpan is at a depth of 14 inches.

Included with this soil in mapping are about 3 percent areas of Rock outcrop and about 10 percent areas of extremely stony Merlin soil.

Permeability is slow. Roots commonly penetrate to a depth of 12 to 20 inches. Runoff is rapid following snowmelt in spring, and the hazard of erosion is high, particularly on long slopes that have considerable runoff. Available water capacity is as low as 1 inch where depth to the hardpan is about 12 inches and the soil is gravelly; it is as high as 4 inches where depth to the hardpan is 20 inches and few pebbles are present. The water-supplying capacity for natural vegetation is 8 to 11 inches.

This soil is used mainly for range and wildlife habitat. Almost all areas of this soil are at a higher elevation than the water supplies, and no soils are irrigated at present. If the soils were carefully irrigated, however, they could be used for irrigated pasture and cereal hay of oats and rye. Alta fescue and Kentucky bluegrass are suited for pasture. This soil is also suitable to dryland pasture.

This soil is better suited to sprinkler irrigation than to other irrigation methods. Cuts made in leveling for borders expose the hardpan in many places because of uneven slopes. The hardpan can be ripped only with great difficulty, and it is mostly too thick to be broken through. Ripping increases the rooting depth and available water capacity to a limited extent. Permanent pasture is suited to this soil.

The climax native plant community on this soil is dominated by Idaho fescue, low sagebrush, and Sandberg bluegrass. A variety of perennial forbs grows in small amounts. Antelope bitterbrush commonly occurs in large amounts.

If the range site deteriorates, Idaho fescue and bitterbrush decrease and low sagebrush and Sandberg bluegrass increase. If the site severely deteriorates, Idaho fescue is nearly eliminated and much ground is left bare.

If the range site is in poor condition, seedbed preparation and seeding are needed. Crested wheatgrass, intermediate wheatgrass, and pubescent wheatgrass are suitable for dryland seeding. Plants selected for seeding need to have good seedling vigor and be drought resistant.

Because of shallow depth to the indurated hardpan and high tendency of the subsoil to shrink and swell on drying and wetting, this soil has important limitations for such community uses as homesites, small buildings, and roads. The hardpan also is a limitation if lagoons, landfill trenches, or shallow excavations are made in this soil. The soil material below the hardpan commonly is very gravelly and, in places, provides a source of gravel. Gravel pits are on this soil near the town of Bly. Shallow soil depth and slow permeability can cause septic tank absorption fields to function poorly and fail in a few years.

This soil is capability subclass Vle.

88E-Yawhee stony coarse sandy loam, 3 to 45 percent slopes. This somewhat excessively drained soil is on volcanic hills and escarpments. It formed in colluvium of very cobbly, pumiceous ash on a very gravelly and loamy buried soil. Slopes predominantly face north. The average slope is about 15 percent. Elevation ranges from 5,000 to 6,500 feet. The average annual precipitation is 20 to 25 inches, the average annual air temperature is 41 to 45 degrees F, and the frost-free season is 10 to 50 days.

Typically, the surface is about 13 inches thick. The upper part is very dark grayish brown stony coarse sandy loam about 2 inches thick and the lower part is very dark grayish brown, very cobbly coarse sandy loam about 11 inches thick. The upper part of the underlying material is dark yellowish brown, very cobbly loamy coarse sand that extends to a depth of about 28 inches. Below this is a buried soil. The upper part is dark brown, very gravelly fine sandy loam to a depth of about 37 inches, and the lower part is dark brown, very gravelly loam to a depth of 60 inches or more. The surface layer and upper part of the underlying material are pumiceous ash and cobbles, pebbles, and stones of basalt or andesite.

Included with this soil in mapping are about 5 percent areas of soils where depth to bedrock is 10 to 20 inches and about 2 percent small areas of Rock outcrop.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is slow, and the hazard of erosion is slight except when the subsurface layer freezes and the surface layer thaws. Under these conditions, runoff is rapid, and the hazard of erosion is high. Available water capacity is as low as 5 inches where the ashy upper part of the soil is 14 inches thick and the soil is mostly gravelly; it is as high as 10 inches where the ashy part of the soil is 35 inches thick and fewer rock fragments are present. The water-supplying capacity for natural vegetation is 15 to 20 inches.

This soil is used mainly for timber and wildlife habitat. Grazing by livestock is limited. The soil is well suited to the production of white fir and ponderosa pine. Douglas-fir, white fir, sugar pine, and incense cedar commonly are present in the stand. White fir dominates the overstory at an elevation of more than 6,000 feet (fig. 20). Timber can be safely harvested by tractor logging in most areas of this soil except where the slope exceeds 30 percent. Such methods as cable logging are used where slopes exceed 30 percent. Logging commonly is not done when the snow is deep in winter and spring. Windthrow is not a particular hazard because the large number of heavy rock fragments in the soil anchor the tree roots. Seedlings of ponderosa pine have a good rate of survival if the site is properly prepared and if locally grown planting stock is used. Christmas trees are produced naturally on this site and also may be planted in openings to increase production.

The climax native vegetation on this soil, at elevations of 5,800 to 6,500 feet, is a mixed conifer forest dominated by Douglas-fir and white fir together with varying amounts of ponderosa pine, sugar pine, and incense cedar. There is 50 to 70 percent canopy cover. The understory is made up of chinquapin, snowberry, and a variety of other shrubs, with about 5 to 15 percent total cover. Sedge, bluegrass, and other shade-tolerant grasses are sparse in the understory with less than 5 percent cover.

Because of slope and potential frost action, this soil has important limitations for such community uses as homesites, small buildings, and roads. Slope and the hazard of seepage also are limitations for lagoons and landfills. Seepage, piping, and the presence of large stones limit the use of this soil for embankments, especially for those that impound water. Because of steepness and irregularity of slopes that exceed about 15 percent, effluent from septic tank absorption fields may surface downslope. This soil is not used for homesites.

This soil is in capability subclass VIe.

89-Yonna loam. This poorly drained soil is on flood plains and low terraces. It formed in alluvium that has much ash in the upper part and in mixed alluvium weathered mainly from diatomite, tuff, and basalt in the lower part. This soil has sufficient sodium to interfere with the growth of most crop plants. Slopes are 0 to 2 percent. Elevation ranges from 4,200 to 4,400 feet. The average annual precipitation is 15 to 18 inches, the average annual air temperature is 42 to 45 degrees F, and the frost-free season is 50 to 70 days.

Typically, the surface layer is very dark grayish brown loam about 11 inches thick. The subsoil extends to a depth of 29 inches. The upper part is very dark grayish brown loam to a depth of about 20 inches; the lower part is dark brown sandy loam to a depth of about 2'9 inches. Below this is a buried soil that is mottled, dark brown and dark grayish brown clay loam and very fine sandy loam to a depth of 60 inches or more. The surface layer and subsoil have a large amount of pumiceous ash. The surface layer is very strongly alkaline, the upper part of the subsoil is moderately alkaline, and the lower part of the subsoil and the buried soil are neutral.

Included with this soil in mapping are about 10 percent areas where the soil is coarse sandy loam and predominantly ash to a depth of more than 40 inches and about 5 percent areas north of the town of Beatty where the soil is underlain by hardpan at a depth of 25 to 40 inches.

Permeability is moderate. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 9 to 16 inches. A water table mostly is at a depth of 2 or 3 feet from March to May, but it may be near or at the surface for 1 week to 2 weeks during this period. It recedes to a depth of 5 feet or more by October. The soil is subject to frequent brief flooding from March to May if it is not protected by dikes.

This soil is used for irrigated crops, range, and wildlife habitat. Pasture is the main irrigated crop, but some cereal hay, mainly oats, is also grown. Alta fescue is suitable for pasture.

This soil is suited to sprinkler and border irrigation. Furrows are not used because of the kinds of crops grown. The rate and amount of water applied need to be carefully adjusted to avoid raising the water table. Drainage is needed to lower the water table below the root zone of crops and to permit reduction of alkali. Dikes along river channels are needed to protect crops from flood damage in many areas. Leaching with irrigation water over a period of years can reduce excess sodium content if the water table has been lowered sufficiently by drainage. Remaining spots of alkali that resist leaching may respond to gypsum or sulfur. Hard crusts tend to form on these spots can hinder or prevent seedling emergence. Application of organic material can soften these crusts and improve soil structure in the surface layer.

Permanent pasture of alta fescue is well suited to all areas of this soil. If the soil is drained and alkali content is sufficiently reduced, alfalfa hay could be grown. A cropping system of 6 to 8 years of alfalfa hay and 1 or 2 years of cereal hay is suitable for drained, protected, and reclaimed areas.

The climax native plant community on this soil is dominated by basin wildrye and a variety of understory grasses, for example, alkali bluegrass, inland saltgrass, mat muhly, and sedge. Western yarrow is a common forb, and rubber rabbitbrush also occurs.

If the range site deteriorates, desirable grasses decrease and rabbitbrush, low value forbs, and saltgrass increase. If it severely deteriorates, rabbitbrush dominates the range site, salts accumulate on the soil surface, and much ground is left bare.

Seedbed preparation and seeding to tall wheatgrass are needed if the range is in poor condition. Plants selected for seeding need to tolerate poor drainage and alkali.

Because of wetness and the hazard of flooding, this soil has important limitations for such community uses as homesites, small buildings, roads, lagoons, and landfills. High potential frost action is also a limitation for homesites, small buildings, and roads. Flooding or wetness can cause septic tank absorption fields to function poorly or fail. Only a few dwellings have been built on this soil.

This soil is in capability subclass IVw.

90-Zuman loamy fine sand. This poorly drained, nearly level soil is on shore lines of formerly drained Tula Lake. It formed in predominantly sandy lacustrine sediment weathered from tuff, diatomite, and basalt. This soil has sufficient sodium to interfere with the growth of most crop plants. The surface is hummocky and uneven in places. Elevation is about 4,060 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is very dark grayish brown loamy fine sand about 11 inches thick. The upper part of the underlying material is mottled, dark brown clay loam that extends to a depth of about 21 inches; the lower part is mottled, very dark grayish brown loamy fine sand to a depth of 60 inches or more. The soil is strongly alkaline throughout.

Included with this soil in mapping are about 5 percent areas where the soil is underlain by hardpan at a depth of about 30 to 40 inches and a few small areas where the soil predominantly is loamy fine sand throughout.

Permeability is moderately slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 5.5 to 7 inches. A water table is at a depth of 0 to 4 feet from March to September. This soil is protected from flooding by dikes.

This soil is used mainly for pasture. It mostly is too wet and too strongly alkaline for crops other than pasture or barley. Only inland saltgrass grows in the most strongly alkali areas. Alta fescue and tall wheatgrass are suitable for pasture. Barley, oats, alfalfa hay, and Irish potatoes also could grow if the soil is adequately drained and is free of alkali.

This soil is better suited to sprinkler irrigation than to other irrigation methods because of the high water intake rate. The rate and amount of water applied need to be carefully adjusted to avoid overirrigation and raising the water table. This soil can be subirrigated from the water table, but subirrigation increases the amount of sodium and salt in the soil. Deep drains are needed to lower the water table below the root zone of crops and to permit leaching of excess sodium and salt. Because the soil mostly does not have drainage outlets, pumping is needed to lower the water table. Much seepage is prevented by lining irrigation ditches and canals that cross this soil.

Leaching with irrigation water can reduce much of the sodium and salt content if the soil is adequately drained. Alkali and dispersed spots that resist leaching may respond to sulfur or gypsum. A long term cropping system that uses more alkali-sensitive crops is suitable for this soil as soon as the sodium and salt content is reduced by leaching. After sufficient reduction of salt and sodium, such a system can include tall wheatgrass or alta fescue pasture for many years followed by barley, either for hay or grain, and then by alfalfa hay. When the soil is totally free of alkali, other small grain and possibly Irish potatoes can be grown.

Because of wetness, this soil has important limitations for such community uses as homesites, small buildings, roads, landfills, and lagoons. Wetness can cause septic tank absorption fields to function poorly or fail. This soil is not used for homesites.

This soil is in capability subclass IIlw.

91-Zuman silt loam. This poorly drained, nearly level soil is on flood plains along the Klamath River. It formed in predominantly sandy sediment weathered from tuff, diatomite, and basalt. The soil has sufficient sodium to interfere with the growth of most crop plants. Elevation is about 4,080 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is very dark gray silt loam about 17 inches thick. The substratum is mottled, dark grayish brown loamy fine sand and fine sand to a depth of 60 inches or more. The soil is strongly alkaline throughout.

Included with this soil in mapping are about 30 percent areas of soil where the surface layer and substratum are only mildly alkaline or moderately alkaline.

Permeability is moderately slow. Roots commonly penetrate to a depth of more than 60 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 5.5 to 7 inches. A water table mostly is at a depth of 1.5 to 3.5 feet from March to September. The soil is subject to frequent flooding; it is, however, partly protected by river dikes.

This soil is used mainly for a few irrigated crops, for example, pasture and barley. Alta fescue is suitable for pasture. Barley can be grown for grain or hay. Most areas of the soil are too strongly alkaline for other crops. Selecting crops that grow in alkali and saline soils is needed to obtain satisfactory yields. If the soil is adequately drained and free of alkali, wheat, oats, alfalfa hay, and Irish potatoes can be grown.

This soil is suited to border and sprinkler irrigation. Most areas have been leveled for irrigation. The rate and amount of water applied need to be carefully adjusted to avoid overirrigation and raising the water table. Deep drains are necessary to lower the water table below the root zone of crops and to permit leaching of excess sodium and salt. The soil can be subirrigated from the water table, but subirrigation decreases the amount of sodium and salt. The soil mostly does not have drainage outlets, and pumping is required to lower the water table. Dikes are needed to protect crops from flooding. Much seepage is prevented by lining irrigation ditches and canals that cross this soil.

Leaching with irrigation water can reduce the alkali and salt content if the soil is adequately drained. Alkali and dispersed spots that resist leaching may respond to sulfur or gypsum. A long term cropping system that uses more alkali sensitive crops is suitable for this soil as soon as the sodium and salt content is reduced by leaching. After sufficient reduction of sodium and salt, the cropping system can include tall wheatgrass and alta fescue pasture for many years followed by barley, either for hay or grain, and by alfalfa hay. When the soil is fully reclaimed, other small grain and possibly Irish potatoes can be grown.

Because of wetness and the hazard of flooding, this soil has important limitations for such community uses as homesites, small buildings, roads, landfills, and lagoons. Flooding and wetness can cause septic tank absorption fields to function poorly or fail. This soil is not used for homesites.

This soil is in capability subclass IIIw.

92-Zuman silty clay loam. This poorly drained, nearly level soil is on the bed of Miller Lake. It formed in predominantly sandy lacustrine sediment weathered from tuff, diatomite, and basalt. It has sufficient sodium to interfere with the growth of most crop plants. Elevation is about 4,080 feet. The average annual precipitation is 10 to 14 inches, the average annual air temperature is 46 to 49 degrees F, and the frost-free season is 80 to 110 days.

Typically, the surface layer is dark grayish brown silty clay loam about 4 inches thick. The upper part of the underlying material is mottled, gray silty clay loam or mottled, grayish brown sandy clay loam that extends to a depth of 17 inches. The lower part is mottled, very dark gray and black fine sand to a depth of 60 inches or more. The substratum is firm and compact below a depth of 30 inches. The soil is very strongly alkaline throughout.

Included with this soil in mapping are about 10 percent areas and long narrow stringers of Laki Variant soil that are mostly less than 50 feet wide and about 5 percent low hummocks and mounds about 1 foot to 3 feet high and 5 to 50 feet across that are scattered over the map unit. These mounds and hummocks have a sandy loam surface layer about 10 to 15 inches thick that is underlain by Zuman soil.

Permeability is moderately slow. Roots commonly penetrate to a depth of about 30 inches. Runoff is very slow, and the hazard of erosion is slight. Available water capacity is 6 to 8 inches. A water table is at a depth of 0 to 4 feet from March to September. The soil is ponded in spring to a depth of about 2 feet or less.

This soil is used mainly for wildlife habitat. It is used to a limited extent for grazing by livestock in summer and fall. Scattered patches of inland saltgrass that grow to a height of about 2 to 4 inches are the main vegetation. This soil would need extensive reclamation to make it suitable for crops.

This soil can be reclaimed by diking, by draining, and by reducing excess sodium and salt. Diking is needed to protect the soil from flooding. The soil does not have natural outlets for drainage, and pumping is needed to lower the water table. Leaching with irrigation water over a period of many years can reduce excess sodium and salt content if water table has been lowered sufficiently by drainage. Tall wheatgrass, barley hay, and other alkali-tolerant crops can be grown in the initial stages of reclamation; when the soil is totally free of alkali, all crops can be grown that are suited to the survey area.

Because of wetness and the hazard of flooding, this soil has important limitations for such community uses as homesites, small buildings, roads, and landfills. Seepage and wetness also are limitations for lagoons. Flooding, moderately slow permeability, and wetness can cause septic tank absorption fields to function poorly or fail. This soil is not used for homesites or small buildings.

This soil is in capability subclass VIw.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area--the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

About 244,170 acres in Klamath County consisted of land in cropland in 1969, according to the agricultural census for that year. The estimated total of irrigated and subirrigated land in the survey area was more than 200,000 acres, including harvested cropland and pasture. The main crops in 1969 were alfalfa hay, Irish potatoes, wheat, barley, oats, rye, and cereal hay. Some parts of the area, for example, the Sprague River Valley and Wood River Valley, have growing seasons that are too short for potatoes and small grain other than rye. Only pasture is grown in the Wood River Valley.

About 200,000 acres of soil in the survey area have excess amounts of sodium and salt, a water table within the rooting zone of crops, or both excessive amounts of sodium and salt and a high water table. At the present time, the best way to increase crop production is to drain the soil and reduce the alkali content in these soils (22). In many areas, yields can be increased by deep ripping the soils that have a hardpan at a depth of less than 3 feet. Crops can be grown in many areas of Bly and Lobert soils if they are cleared of woods. Small areas of Calimus, Capona and Harriman soils that are now in range could be cultivated. Most uncultivated, but arable, soils are at a higher elevation than the irrigation water supplies.

Mint, horseradish, onions, some varieties of beans, radishes, lettuce, rhubarb, and turnips can be grown in the survey area. Some varieties of sweet corn grow well in most years. Tomatoes and green peppers require careful protection from frost. Apples, strawberries, currants, and gooseberries also can be grown.

Each year some cropland and pastureland are used for homesites, for industrial use, and for urban expansion. According to the Klamath County Planning Commission, in the 7-year period before 1976, 1,265 acres of arable soils in the survey area, or about 180 acres each year, was converted to urban and built-up uses.

There is a hazard of water erosion on about 85,550 acres of cropland soils in the survey area. If not carefully managed, soils with slopes of more than about 2 percent are subject to the washing away of soil particles at the surface caused by natural runoff from rainfall and snowmelt, and also by runoff from irrigation. Sloping cropland soils are particularly susceptible to erosion when the subsurface layer is frozen and there is a large amount of runoff from melting snow. The greatest damage is in winter and spring in those places where fall tillage has left the soil surface bare and unprotected.

Sloping areas of Calimus, Harriman, Dodes, and Capona soils are among the most easily eroded if not protected by adequate plant cover. Surface flow and sprinkler irrigation require careful application of water at rates that do not detach surface soil particles and wash them downslope. Leaving organic residue on the surface to protect the soil from winter and spring runoff, shortening irrigation borders and furrows so that nonerosive heads of water can be used, and selecting sprinkler nozzles that produce nonerosive sprays, help reduce soil erosion. Other factors, for example, available water capacity, infiltration rate, permeability, kind of crop, and slope need to be considered in determining rate of water application for irrigation.

The sandy Fordney and Poe soils and other soils are subject to wind erosion in spring, mainly from March to May. These soils make up 77,618 acres. The hazard of erosion is most severe in those areas where the soil surface is dry and is left bare during these months. Other soils that are subject to wind erosion are the Henley, Laki, Modoc, and Calimus soils that have a surface layer of fine sandy loam to loamy fine sand. Organic residue left on the surface and placing furrows and conducting other operations at right angles to the prevailing wind direction help reduce the hazard of wind erosion. About 20,079 acres is subject to wind and water erosion.

Tillage pans, which form readily in the upper part of Calimus and Lobert soils are firm and compact layers of low intake rates that are mostly at a depth of 5 to 14 inches. Such pans are generally resistant to root penetration and to downward movement of water and air.

These pans are caused by repeated tillage at the same depth each year, and the most strongly developed pans are produced if grain is grown each year. Formation of such pans can be reduced to some extent by varying the depth of tillage and by growing crops other than grain. Occasional plowing or chiseling to a depth of below 14 inches breaks up the pans. Some dryland fields of Calimus and Lobert soils have been abandoned for cultivation because of declining productivity caused by these pans.

Compacted zones, mostly at a depth of between 14 and 30 inches also occur in Calimus, Lobert, and some other soils that are farmed with tractors and other heavy equipment. Land leveling with heavy earth moving equipment commonly produces compact layers that may have lowered permeability. Cropping systems that include such deep rooted crops as alfalfa for a number of years after leveling help reduce compaction. Deep ripping has little effect in reducing compaction. Using the lightest available equipment to perform the needed operation and using crawler tractors that eliminate running a tractor wheel in the bottom of the plow furrow also help reduce deep compaction.

Weakly cemented to extremely hard and indurated hardpans occur in many soils. These soils make up about 67,186 acres of the survey area, and mainly include the Henley, Poe, Barkley, Bedner, Calder, Hosley, Modoc, Scherrard, and Yancy soils. All of these soils have a hardpan at a depth of less than 40 inches.

Many soils, including Henley, Poe, Hosley, and Scherrard soils have a high water table under natural conditions and have accumulated excessive amounts of sodium. Thickness of the hardpan ranges from a minimum of about 4 inches in a few Poe soils to 48 inches or more in the Yancy soils. Percolation tests made on Yancy soil show that the hardpan has very slow permeability. Except in scattered cracks and fissures, few or no roots penetrate more than a few inches into the hardpan. Very fine roots commonly are matted on top of it. Water from irrigation accumulates on top of the hardpan in the well drained Modoc soils and increases the height of the water table in the Henley, Poe, Hosley, and Scherrard soils.

Deep ripping or subsoiling to a depth of 3 feet or more commonly is done to break up the hardpan. The ripper tooth, in most cases, is pulled through the soil by a heavy tractor at intervals of about 3 feet in one direction and again at 3 feet intervals at right angles to the first direction. For greatest shattering, ripping is done when the hardpan is nearly dry. It is most effective when the ripper tooth penetrates through the hardpan. Little is gained simply by ripping into the upper part of the hardpan.

Drainage is a problem on about 219,648 acres of soil that is used for cropland and pastureland. Soils that have a high water table under natural conditions which restrict the choice of crops include Algoma, Chiloquin, Dilman, Henley, Hosley, Kirk, Ontko, Pit, Poe, Scherrard, Sycan Variant, Teeters, Tulana, Yonna, and Zuman soils. On many of these soils, alkali, flooding, and cold temperatures are also problems. Such soils as Tulana, Algoma, and Teeters lack drainage outlets, and are drained by pumping from deep canals into diked river channels, mainly the Klamath River.

Many nearly level soils that are well drained to excessively drained under natural conditions have a water table that is caused by irrigation and seepage from canals. Calimus, Fordney, Modoc, and Harriman soils that have slopes of less than 2 percent can have a water table at a depth of between 2 to 5 feet. Adequate outlets for drains are possible for most of these soils.

Many soil characteristics and qualities influence the ease with which soils can be drained. A cemented hardpan can serve as a barrier to the downward movement of water and, where it is thick enough, can prevent effective artificial drainage. Cutbanks made in such sandy soils as the Fordney soils can cave or require expensive annual maintenance. Subsidence is a problem following drainage on the organic Lather soils, as well as instability of cutbanks made out of organic material. Excess alkali and excess salt can affect the quality of discharged drain water. Flooding can damage structures and fill in drains. Soil permeability likewise can be reduced following removal of excess salt during drainage. Soils that have a fine or moderately fine texture, for example, Pit silty clay and Malin clay loam, commonly are so slowly permeable that water can move through them only over a long period of time. Such soils are difficult to drain. Open drains require periodic cleaning and deepening to be effective.

Flooding can occur on Chiloquin, Chock, Chinchallo, Kirk, Klamath, Ontko, Malin, Pit, Scherrard, and Yonna soils if they are not protected by dikes. The Algoma, Histosols, ponded, Teeters, Tulana, and Zuman soils are on drained lake bottoms and are subject to inundation if not protected. Flooding occurs mostly in spring. The total acreage of soils in the survey area that are subject to flooding is 232,862.

Excess amounts of sodium and salt affect about 103,308 acres of soils in the survey area. Sodic soils are formed by accumulation of sodium which is absorbed on clay particles in the soil. Compounds of sodium, calcium, magnesium, and potassium, mainly bicarbonates, carbonates, chlorides, and sulfates make up the excess salts that accumulate in the soils. Both excess sodium and excess salt result from dissolved salts in the ground water. Salt is concentrated when water is removed by plant roots and evaporation. Most of this sodium and salt is in the upper 20 inches of the unreclaimed soil. Some drained and partially reclaimed soils have a smaller amount of sodium and salt in the upper part and a larger amount at a depth of below 20 inches because leaching is more effective, at least initially, in the upper part of the soil.

The rate at which sodium and salt can be reduced in the soil depends on the permeability of the soil, percentage of clay in the soil, depth to the water table, the total amounts of sodium and salt, and the quality of the irrigation water that is used for leaching. The overall quality of most irrigation water in the survey area is good. Such slowly permeable soils as the Malin soil that have a high amount of clay and excess sodium can be reclaimed only over a long period of time. Medium to fine textured soils that have a hardpan, for example, the Henley, Hosley, and Scherrard soils also reclaim slowly. Because they have a small amount of clay and excess sodium and have rapid permeability, Poe soils reclaim readily compared to finer textured alkali soils in the survey area. The loamy, moderately permeable Laki and Yonna soils are somewhat intermediate in their potential for reclamation as compared to other soils.

To permit leaching of sodium and salt, the water table must be lowered to a depth at which upward capillary flow from saline ground water to the root zone cannot occur. Depth to the water table generally should be at least 5 feet. Where feasible, hardpans may be ripped to permit downward percolation of water and leaching of dissolved salts.

As excess salt is removed, permeability of the soil tends to decrease. Salt commonly has a granulating or flocculating effect on soil particles and can increase permeability to water and air. Excess sodium tends to disperse soil particles and reduce permeability. Because excess salt generally is removed first by leaching, a gradual increase in permeability may result. The addition of gypsum and sulfur to the soil helps to improve the tilth and physical structure in the surface layer. These additions also can increase infiltration and permeability, and they combine with sodium to produce soluble salts that can then be leached from the soil.

The selection of crops depends on the total amount of excess sodium and salt in the soil. Of all crops commonly grown in the survey area, barley is most tolerant of excess sodium and excess salt. Alfalfa is tolerant of excess sodium but is only moderately tolerant of excess salt. Alta fescue is moderately tolerant and tall wheatgrass is highly tolerant to both excess sodium and excess salt. Wheat, oats, and rye grown for hay are moderately tolerant to excess sodium and excess salt.

Many nearly level, well drained Calimus and Modoc soils have a small percentage of scattered alkali spots. Some gently sloping to moderately sloping Calimus soils have dispersed spots, or slick spots, that are not strongly alkaline. These spots can be treated with gypsum and sulfur to improve physical condition and tilth and to reduce adsorbed sodium.

Tillage commonly is a problem on most wet soils in the survey area, particularly on those soils that have a moderately fine to fine textured surface layer. Such soils need to be cultivated within a narrow range of moisture content to permit clean scouring of the tillage implement and produce the desired size of clods or soil aggregates. Generally, only field experience is reliable for the equipment operator to judge this moisture condition.

Burning is a hazard on Lather soils which are made up mostly of organic matter. The hazard from fire is severe when the soils become dry. Precautions against accidental fire from smoking, sparks from equipment, and other causes need to be taken when working with these soils. Once started, fires tend to be extremely difficult to extinguish.

Furrow, border, sprinkler, and other methods of irrigation are used on about 256,400 acres in the survey area. The choice of system used should depend on soil characteristics, cropping systems, available labor, and relative cost. Sprinkler irrigation rapidly is replacing other methods, especially on such sandy soils as Fordney and Poe soils and on other soils where Irish potatoes are grown. Water can be applied more evenly and in more precise amounts than with other systems. Sprinklers are suitable for nearly all of the cropland soils except those that have infiltration rates slower than about 0.10 inch per hour. This system is well suited to sandy soils that have a high intake rate, to soils that have slopes in excess of more than 8 percent or that have complex slopes, and to soils that are not deep enough to level. Sprinklers can be used on slopes between 0 to 35 percent.

Where water is applied in borders and furrows, the soil surface must be even and the slope as uniform as possible. Land that is not properly graded and leveled will have low spots that will be overirrigated and high spots that will be underirrigated, resulting in uneven crop growth and lowered yields. The lengths of borders and furrows are determined by such factors as slope, infiltration rate, and available water capacity. Level borders have slopes up to 0.1 percent, and graded borders have slopes between 0.1 to 4 percent. Furrows are suited to slopes up to about 8 percent if the furrow slope does not exceed 2 percent. Corrugations are suitable for close growing crops on slopes between 1 to 8 percent.

Subirrigation from a controlled water table is used for many soils, for example, the Tulana, Algoma, Teeters, Lather, and Kirk soils. With this method, the water table is controlled by raising and lowering the water level in canals and ditches by pumping, or by other methods. Slight salinization is presently taking place in many areas of Tulana, Lather, and Kirk soils as a result of this irrigation method. Algoma and Teeters soils are strongly alkaline and very strongly alkaline. Water also can be applied to all of these soils at the surface.

Available water capacity is the amount of water a soil can store for use by plants. Many factors, for example, effective rooting depth of the soil; texture of soil horizons or layers; total volume of rock fragments present; and the amounts of ash, organic matter, and diatomaceous sediment present, affect the ability of soils to store water. Soils that are deep tend to store more water than those that are shallow if other conditions are about the same. Soils that have a high amount of silt and clay store more water than soils made up predominantly of sand, except where the sand is mostly ash. Available water capacity decreases in proportion to the volume of such rock fragments as hard lava pebbles and cobbles in the soil. Such materials as organic matter, ash, and diatomaceous sediment greatly increase available water capacity if they are present in significant amounts.

The time to irrigate and the amount of water to apply mostly depend on the available water content within the root zone of the soil, the kind of crop and its stage of development, and air temperatures. Water can be applied to most crops when the upper one-third of the root zone decreases to about one-half of its available water capacity. Irish potatoes, however, require a more moist root zone, especially when tubers are developing. Small grain crops need only light applications of water in early stages of germination and development. Water in excess of that required for plant growth can help reduce alkali if good drainage is provided. Overirrigation can result in loss of soluble plant nutrients as well as waterlogging that can reduce crop yields. Such instruments as gypsum blocks that measure the amount of available soil moisture are useful in determining the time to irrigate.

Summary of soil nutrient conditions

Bert G. Wilcox, Klamath County extension agent, prepared this section.

Major nutrient element requirements. All mineral soils require nitrogen for crop production. Organic soils also require nitrogen, except those areas that are acid. Nitrogen requirements range from 60 to 100 pounds per acre for cereal and pasture crops and from 125 to 200 pounds per acre on Irish potatoes. These rates vary with the soil and crop rotation systems. Sources of nitrogen used in the survey area are calcium nitrate, ammonium nitrate, anhydrous ammonia, aqua ammonia, urea, and ammonium sulphate.

According to laboratory reports, phosphate levels in the soil range from 4 to 40 parts per million. From 100 to 150 pounds per acres of phosphorus pentoxide need to be applied to potatoes annually. Fertilizer experiments, however, have not shown a yield increase from alfalfa when phosphorus at rates up to 300 pounds of phosphorus pentoxide per acre is applied to the surface of an established stand. Single superphosphate and triple superphosphate are the most common forms of phosphorus used on potatoes, some small grains, and some pasture seedings.

Potassium levels are high in most soils in the survey area. Experiments have failed to show yield increase from pasture, cereal, and alfalfa crops when potassium is applied. Yield and quality in potatoes, however, have been increased by application of 200 pounds per acre of potassium. Potassium chloride has given better results in potatoes than other potassium compounds. Potassium nitrate and potassium sulphate are also used.

Mineral soils are deficient in sulfur. All crops in the survey area respond to applications of sulfur. Sulfur requirements are as high as 50 pounds per acre annually in potatoes and alfalfa. Sources of sulfur are ammonium sulfate, ammonium phosphate sulfate, ammonium single superphosphate, single superphosphate, gypsum, and elemental sulfur.

Micronutrient element requirements. Experiments have not shown increase in alfalfa yields when boron is applied with soil tests as low as 0.4 parts per million. Boron deficiencies have been found in cereal or pasture crops. Some alkaline muck soils have boron toxicity at levels of 18 parts per million, but because of the high pH values of these soils, barley can be grown.

There are indications of manganese toxicity in mineral soils that have low pH values, but more research is needed. Low levels of manganese have appeared in plant tissue taken from crops that are grown in muck soils.

Copper deficiency in livestock pastured on mineral and muck soils is common throughout the survey area. Copper deficiency symptoms also are prevalent in cereal crops that are raised in acid muck soil. Foliar applications of copper have overcome deficiency symptoms and increased yields in oats. Incorporation of the copper into moist soil has given the best results. Cattle feed needs to be supplemented with copper.

Zinc deficiency symptoms occur in potatoes that are raised in alkaline mineral soils. These deficiencies can be corrected by applying zinc or by using acid forming fertilizers that will make the zinc more available to the plant.

Molybdenum levels that are toxic to livestock have been found in areas of alkaline muck soils. These soils are the same as those in which copper deficiency occurs. Soil leaching reduces molybdenum level in soil.

Selenium deficiencies are common in cattle and sheep grazing forages grown in muck and mineral soil.

Two soil and plant tissue surveys made ten years apart show a decrease of pH level in sandy soils. In 1965 the lowest pH level was 5.4; in 1975 it was 4.7. This change is attributed to the large application of acid-forming fertilizers and to the leaching effect from irrigation water. Research is just beginning to determine the effect of pH values on the availability of other plant nutrients in the soil.

In 1968 an experiment was conducted in which lime was applied to a field at a rate of 1 ton, 2 tons, and 3 tons per acre. The field went through a crop rotation system of alfalfa, cereals, and potatoes. The first indication of favorable crop response was noticed on 1-year-old alfalfa in 1976.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil or that a given crop is not commonly irrigated.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 6.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; soil amendments and alkali reduction; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; cropping systems that mix row crops and/or small grain with hay or pasture; and timeliness of all fieldwork.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown; that good quality irrigation water is uniformly applied in proper amounts as needed; and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops (26). The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability c/asses, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by w, s, or c because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Rangeland

Samuel F. Greenfield, range conservationist, Soil Conservation Service, prepared this section.

About 352,000 acres or about 34 percent of the survey area is rangeland. The remainder is grazeable woodland, cropland, and bottom land that has potential for cultivation. The rangeland is mostly on rock benches, or hills and high mountain ridges that rise sharply from the basin floor. The terrain commonly is rough, very stony, and rocky; in many places, it considerably hinders livestock from grazing.

A forested pumice zone of about 150,000 acres lies to the north of Fort Klamath and the Sprague River Valley. This area has poor soil and harsh climatic conditions and the potential for forage improvement is significantly less than that in the Klamath basin and surrounding hills. Typically, forage producing plants are sparse on pumice soils, and livestock use mostly is determined by availability of water and distance to nearby meadows.

Range soils of the Klamath basin characteristically supports stands of western juniper and a wide variety of palatable shrubs which provide important winter range for mule deer. Palatable shrub production, however, has been severely reduced because of excessible browsing by deer and probably by livestock. Juniper dominated areas especially have been severely affected.

Natural plant communities are rare in the survey area, because of periodic wildfire, excessive utilization, and other disturbances. Severely depleted range is a producing ground for noxious weeds, for example, medusahead wildrye, which vigorously invades clayey soils and nearly eliminates the grazing value of the area. The amount of forage presently produced on more than 80 percent of the rangeland is estimated at less than half that originally produced. Reestablishing productivity through livestock control and proper forage management practices are the main management concerns.

Nearly half of the farm income is obtained from livestock, principally from cattle. Successful ranching is largely dependent upon irrigated pasture during part or all of the summer grazing period. Ample pasture, hay, and other feed need to be provided at all times of year so that cattle can be fed until market conditions are most favorable. Some ranchers use forested range areas for late spring through fall grazing. Small producers are increasing fall calving on the high priced irrigated pastureland.

Because custom feed lots are declining in the Klamath basin, some producers on the larger ranches are keeping cattle at home until time for market. In addition, a large number of yearling cattle are shipped from California to graze during the summer on the 26,000 acres of irrigated meadow in the Fort Klamath Valley.

Where climate and topography are about the same, differences in the kind and amount of vegetation that rangeland can produce are related closely to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Table 7 shows, for each kind of soil, the name of the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community. Soils not listed cannot support a natural plant community of predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing, or the soils are used for such other purposes as urban developments or cropland. The following are explanations of column headings in table 7.

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Soils that produce a similar kind, amount, and proportion of range plants are grouped into range sites. For those areas where the relationship between soils and vegetation has been established, range sites can be interpreted directly from the soil map. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production refers to the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the amount and distribution of precipitation and the temperatures are such that growing conditions are substantially better than average; in a normal year these conditions are about average for the area; in an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential natural plant community. Vegetation that is highly palatable to livestock and vegetation that is unpalatable are included. Some of the vegetation can also be grazed extensively by wildlife.

Characteristic species of grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community on each soil are listed by common name. Under *Composition,* the expected proportion of each species is presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluation of the present condition of the range vegetation in relation to its potential. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the maximum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Woodland management and productivity

Gene Hickman, range conservationist, Soil Conservation Service, assisted in preparing this section.

About 387,000 acres or 37 percent of the survey area is woodland (23). The remainder is rangeland, cropland, pasture, and water areas. Woodland areas are on rock benches, lava plains, and escarpments which have an average annual precipitation of more than 16 inches. They are extensively north of the Langell, Yonna, and Swan Lake Valleys and along the western edge of the survey area in the Cascade Mountains. Scattered areas of woodland also are in the valleys and on Bryant and Stukel Mountains in the southern part of the survey area. In this survey, woodland does not include areas that have stands of western juniper, exclusive of other trees; such areas are considered as rangeland.

The most widespread tree in the woodlands is ponderosa pine. It occurs in pure stands or dominates the overstory on low elevation escarpments that face south and on rock benches and lava plains. Douglas-fir, white fir, sugar pine, incense cedar, and lodgepole pine are associated with ponderosa pine in many parts of the survey area. Douglas-fir or white fir, or both, generally dominate stands on north-facing slopes at lower or middle elevations. Incense cedar and sugar pine frequently are scattered within these stands if both ponderosa pine and white fir are present. North-facing slopes are dominated by nearly pure stands of white fir at moderately high elevations, approximately 5,800 to 6,800 feet, and by lodgepole pine at higher elevations. The high elevation environments apparently are too cold for other conifer species. Both sugar pine and Douglas-fir are geographically limited within the area, probably because of climatic restrictions. Sugar pine does not grow in forests of the southeastern part of the area, and Douglas-fir does not grow in forests of the eastern half.

The most productive sites for ponderosa pine are the pumiceous soils in-the northern part of the survey area, particularly the Steiger, Lapine, Maklak, and Shanahan soils. Collier soils also have considerable pumiceous ash and cinders and have a very high site index for ponderosa pine (20). The least productive sites for pine are on the shallow Nuss soils and on the moderately deep Royst soils. These soils are on rock benches and south-facing escarpments at lower elevations and have the lowest site index for pine in the survey area.

The site index for ponderosa pine is higher on south-facing slopes of the Lapine soil than on adjacent, comparable north-facing slopes in the survey area. This may be due to warmer soil and air temperatures and also because the water-supplying capacity can be greater because of the higher potential for evaporation and transpiration on south-facing slopes. The Lapine soil can hold water in excess of that which it can supply through evaporation and transpiration, and precipitation also exceeds the potential for evaporation and transpiration in nearly all areas of Lapine soils. Water-supplying capacity, therefore, can be a limitation in tree growth as well as colder temperatures on these soils. On Shanahan and Woodcock soils, available water capacity and the water--supplying capacity mostly are less than the potential for evaporation and transpiration. On these soils, the site index for ponderosa pine is higher on north-facing slopes than on south-facing slopes. The effectiveness of precipitation may be greater on the north-facing slopes for these soils. Woodcock gravelly loam, 1 to 5 percent slopes, has a higher average site index than Woodcock soils on either north- or south-facing slopes. This soil is near the Cascade Mountains and is estimated to be near the upper part of the precipitation range for Woodcock soils.

Table 8 contains information useful to woodland owners or forest managers planning use of soils for wood crops. Mapping unit symbols for soils suitable for wood crops are listed, and the ordination (woodland suitability) symbol for each soil is given. All soils bearing the same ordination symbol require the same general kinds of woodland management and have about the same potential productivity.

The first part of the ordination symbol, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter o indicates insignificant limitations or restrictions. If a soil has more than one limitation, priority in placing the soil into a limitation class is in the following order: x, w, t, d, c, s, f, and r.

In table 8 the soils are also rated for a number of factors to be considered in management. *Slight, moderate,* and *severe* are used to indicate the degree of major soil limitations.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings. Plant competition is not considered in the ratings. Seedlings from good planting stock that are properly planted during a period of sufficient rainfall are rated. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate,* 25 to 50 percent; and *severe,* more than 50 percent.

Considered in the ratings of *windthrow hazard* are characteristics of the soil that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate,* that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe,* that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The *potential productivity* of merchantable or *important trees* on a soil is expressed as a *site index.* This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Important trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Woodland understory vegetation

Understory vegetation consists of grasses, forbs, shrubs, and other plants. Some types of forest, under proper management, can produce enough understory vegetation to support grazing of livestock or wildlife, or both.

The quantity and quality of understory vegetation vary with the kind of soil, the age and kind of trees, the density of the canopy, and the depth and condition of the forest litter. The density of the forest canopy affects the amount of light that understory plants receive during the growing season.

Table 9 shows, for each soil suitable for woodland, the potential for producing understory vegetation. The table also lists the common names of the characteristic vegetation that grows on a specified soil and the percentage composition, by air-dry weight, of each kind of plant. The kind and percentage of understory plants listed in the table are those to be expected where canopy density is most nearly typical of forests that yield the highest production of wood crops.

The total production of understory vegetation is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the soil moisture is above average during the optimum part of the growing season; in a normal year soil moisture is average; and in an unfavorable year it is below average.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 10 shows, for each kind of soil, the degree and kind of limitations for building site development; table 11, for sanitary facilities; and table 13, for water management. Table 12 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 10. A ***slight*** limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A ***moderate*** limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A ***severe*** limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually, difficult to excavate, is indicated.

Dwellings and small commercial *buildings* referred to in table 10 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 10 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 11 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight,* soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe,* soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good, fair,* or *poor,* which, respectively, mean about the same as the terms *slight, moderate,* and *severe.*

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 11 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 12 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads**.** Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 16 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *grave/* are used in great quantities in many kinds of construction. The ratings in table 12 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 16.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 13 the soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 14 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 14 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 11, and interpretations for dwellings without basements and for local roads and streets, given in table 10.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife habitat

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 15, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor**.** A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, excess sodium and excess salt, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, excess sodium and excess salt, sulfur deficiency, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, excess sodium and excess salt, sulfur deficiency, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluebunch wheatgrass, buckwheat, sedge, and basin wildrye.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are ponderosa pine, white fir, incense cedar, and western juniper.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture. Examples of shrubs are mountain-mahogany, bitterbrush, snowberry, and big sagebrush.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, excess sodium and excess salt, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are mannagrass, redtop, saltgrass, and rushes, sedges, and reeds.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, and shrubs. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include quail, pheasant, meadowlark, dove, and rabbit.

Wood/and habitat consists of areas of conifers and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include blue grouse, thrushes, woodpeckers, gold mantled squirrels, gray fox, raccoon, deer, and bear.

Wet/and habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Range/and habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include antelope, white-tailed deer, desert mule deer, sage grouse, and meadowlark.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

Engineering properties

Table 16 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 16 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 16 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (3) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (2).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes--eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 21. The estimated classification, without group index numbers, is given in table 16. Also in table 16 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 17 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field-particularly soil structure, porosity, and gradation or texture-that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 17. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops

can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 18 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 18 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Cemented pans are hard subsurface layers, within a depth of 5 or 6 feet, that are strongly compacted (indurated). Such pans cause difficulty in excavation. The hardness of pans is similar to that of bedrock. A rippable pan can be excavated, but a hard pan generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Laboratory data

Physical and chemical properties of 14 selected soils in the area are shown in tables 19 and 20. Profiles for these soils are described in the section "Soil series and morphology." Analyses for all of these soils except the Klamath series were made at the Soil Conservation Service Characterization Laboratory at Riverside, California. Analyses for the Klamath series were made at Oregon State University Soil Testing Laboratory (1, 4). The determinations are described in Soil Survey Investigations Report No. 1 (27).

All samples were collected from pits. After air drying, the samples were crushed and passed through a 2-millimeter round-hole screen. The fraction greater than 2 millimeters in diameter is reported as weight percentage of the total sample. Analysis was made on soil material less than 2 millimeters in diameter. Results are reported on an ovendry basis. Empty columns indicate that the determination was not made.

The particle-size distribution analysis was made by the pipette method (organic matter and soluble salts removed) with dispersion in sodium hexametaphosphate and mechanical shaking (13). Reaction determinations were made by glass electrodes using soil-water ratio mentioned. Organic carbon was determined by wet combustion by use of the Walkley-Black method. Total nitrogen was obtained by the Kjeldahl method.

Extractable iron was reduced and extracted by sodium dithionite and the extract was titrated with potassium dichromate.

Extractable cations were leached with 1 N NH40Ac. Extractable sodium and potassium were determined by flame photometry; calcium by permanganate titration; and magnesium gravimetrically as pyrophosphate. Extractable acidity was determined by the triethanolaminebarium chloride method. Cation-exchange capacity (CEC) is the sum of extractable cations and extractable acidity; base saturation is the sum of extractable calcium, magnesium, sodium, and potassium as percentage of the cation-exchange capacity (14).

The amount of water and the bulk density at 1 /3-bar tension were determined on plastic-coated clods in a porous-plate pressure cooker(6). Water held at 15-bar tension was measured on disturbed samples in a pressure membrane apparatus. Linear extensibility (LE) is the change in the diameter of a soil clod between the moisture content under 1 /3-bar tension and ovendryness and is expressed as a coefficient (COLE). Clay mineralogy was determined by the X-ray diffraction method.

Engineering test data

Samples from soils of 12 series representative of the area were tested by standard AASHTO procedures to help evaluate the soils for engineering purposes. Only selected layers of each soil were sampled. Of the 12 series tested the Kirk, Lorella, Modoc, Poe, Tulana, and Woodcock series are described in the section "Soil series and morphology." Although descriptions of the other series tested are not available, the descriptions in the section "Soil series and morphology" would closely approximate the tested soils. The results of these tests are shown in table 21. The samples tested do not represent the entire range of soil characteristics in the area, or even within each series. The results of the tests, however, can be used as a general guide in estimating the physical properties of the soils. A comparison of these and other systems of size limits for soil separates can be found in the PCA Soil Primer (16). Tests made were for moisture-density relationships, grain-size distribution, liquid limit, and plasticity index.

In the moisture density, or compaction, test a sample of the soil material is compacted several times with a constant compactive effort, each time at a successively higher moisture content. The moisture content increases until the "optimum moisture content" is reached. After that the density decreases with increase in moisture content. The highest density obtained in the compaction test is termed "maximum dry density." Moisture-density data are important in construction, for as a rule, optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

The results of the mechanical analysis, obtained by combined sieve and hydrometer methods, can be used to determine the relative proportions of the different size particles that make up the soil sample. The percentage of fine-grained material determined by the hydrometer method should not be used in determining textural classes of soils.

Liquid limit and plasticity index are discussed in the section relating to Engineering properties.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (21). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or mapping units, of each soil series are described in the section "Soil maps for detailed planning."

Algoma series

The Algoma series consists of very deep, poorly drained sodic soils on flood plains and drained lake bottoms. These soils formed in lacustrine sediment. Slopes are 0 to 1 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 47 to 51 degrees F. The soil is wet throughout in most months unless it is drained.

Typical pedon of Algoma silt loam, in an area of irrigated pasture, about 8 miles southwest of Klamath Falls, 2,100 feet south and 700 feet west of the northeast corner sec. 9, T. 40 S., R. 8 E.:

Ap-0 to 11 inches; black (10YR 2/1) silt loam, gray (10YR 5/1) dry; weak medium platy structure; slightly hard, friable, slightly sticky and nonplastic; many roots; many very fine pores; weakly effervescent; strongly alkaline; abrupt smooth boundary.

C1-11 to 24 inches; grayish brown (2.5Y 5/2) silt loam, white (N 8/) dry; common fine olive brown mottles; weak thin platy structure; slightly hard, friable, slightly sticky and nonplastic; many roots; common very fine tubular pores; weakly effervescent; strongly alkaline; abrupt smooth boundary.

C2-24 to 30 inches; gray (2.5Y 5/1) silt loam, white (N 8/) dry; common medium light olive brown (2.5Y 5/ 4) mottles; weak thin platy structure; slightly hard, friable, slightly sticky and nonplastic; common roots; common very fine tubular pores; strongly alkaline; abrupt smooth boundary.

IIC3-30 to 34 inches; dark grayish brown (2.5Y 4/2) fine sand, light gray (10YR 7/1) dry; massive; soft, very friable; common roots; many very fine pores; strongly alkaline; gradual smooth boundary.

IIC4-34 to 60 inches; dark gray (2.5Y 4/1) fine sand, light gray (10YR 6/1) dry; common medium olive brown (2.5Y 4/4) mottles; massive; soft, very friable; common very fine roots; many very fine pores; moderately alkaline.

Some part of the mollic epipedon has more than 15 percent exchangeable sodium, decreasing at depths below 20 inches. The soil is calcareous at depths between 10 and 20 inches. The mollic epipedon is 7 to 15 inches thick. Estimated bulk density is 0.4 to 0.7 grams per cubic centimeter. The sandy IIC horizon is at a depth of 20 to 40 inches.

The A horizon has neutral or 10YR hue; value of 4 or 5, dry; and chroma of 0 or 1, moist and dry. The C horizon has neutral, 10YR, or 2.5Y hue; value of 3 to 6 moist, and 6 to 8, dry; and chroma of 0 to 2, moist and dry. It is mottled or has neutral hue.

Barkley series

The Barkley series consists of moderately deep, well drained soils on terraces. These soils formed in sediment that has a small amount of ash. Slopes are 0 to 8 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F. The soil generally is moist, but it is dry at depths between 4 and 12 inches for 65 to 90 days during the 4-month period following June 21.

Typical pedon of Barkley loam, 0 to 2 percent slopes, in an area of irrigated pasture, about 2 miles south of Wolf Butte in the Sprague River Valley, in the NE1/ 4SE1/4 sec. 31, T. 35 S., R. 10 E.:

Ap-0 to 7 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak thin platy structure; soft, very friable, slightly sticky and nonplastic; many very fine roots; many very fine pores; neutral; gradual smooth boundary.

A3-7 to 16 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure; soft, very friable, slightly sticky and nonplastic; many very fine roots; many very fine pores; neutral; gradual smooth boundary.

B1-16 to 21 inches; dark brown (10YR 3/3) loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; few fine and very fine tubular pores; neutral; gradual smooth boundary.

B2t-21 to 28 inches; dark brown (10YR 3/3) sandy clay loam, light brownish gray (10YR 6/2) dry; moderate medium subangular blocky structure; hard, friable, sticky and slightly plastic; many very fine roots; many very fine pores; few thin clay films on peds and in pores; neutral; clear smooth boundary.

IIC1sim-28 to 35 inches; dark brown (10YR 3/3) gravelly sandy clay loam, light brownish gray (10YR 6/2) dry; massive; very hard, firm and brittle; weakly cemented; common very fine roots; many very fine pores; 20 percent pebbles; neutral; gradual smooth boundary.

IIC2-35 to 60 inches; dark brown (10YR 4/3) gravelly sandy loam, very pale brown (10YR 7/3) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine pores; 25 percent pebbles; neutral.

Solum thickness and depth to the hardpan are 20 to 35 inches. The mineralogy of the solum is mixed and includes about 10 to 30 percent pumiceous ash in the upper part of the solum. The argillic horizon has 5 to 20 percent hard lava pebbles.

The A horizon has value of 2 or 3, moist and 4 or 5, dry. The B2t horizon has value of 5 or 6 and chroma of 2 or 3, dry. It has 27 to 35 percent clay. The IIC horizon, below the hardpan, has 20 to 35 percent pebbles.

Bedner series

The Bedner series consists of moderately deep, moderately well drained soils on low terraces. These soils formed in mixed alluvial and lacustrine sediment. Slopes are 0 to 1 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 47 degrees F. The mean annual soil temperature is about 47 to 50 degrees F. The soil generally is moist, but it is dry at depths between 4 and 12 inches for 70 to 100 days during the 4-month period following June 21.

Typical pedon of Bedner clay loam, in an area of rangeland, in Swan Lake Valley, about 800 feet east of the northwest corner sec. 32, T. 37 S., R. 10 E.:

A1-0 to 6 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak thick platy structure; very hard, firm, sticky and plastic; many very fine roots; many very fine tubular pores; neutral; abrupt smooth boundary.

B2t-6 to 18 inches; very dark brown (10YR 2/2) clay, gray (10YR 5/1) dry, dark brown (10YR 3/3) crushed; strong medium prismatic structure parting to moderate fine angular blocky; very hard, very firm, very sticky and very plastic; many very fine roots; many very fine tubular pores; nearly continuous stress cutans on peds; neutral; clear smooth boundary.

B3t-18 to 21 inches; dark brown (10YR 3/3) clay loam, light brownish gray (10YR 6/2) dry, dark grayish brown (10YR 4/2) crushed; moderate fine angular blocky structure; hard, firm, sticky and plastic; many very fine roots; many very fine tubular pores; common, moderately thick clay films on peds; neutral; abrupt smooth boundary.

C1sim-21 to 31 inches; dark brown (10YR 3/3) duripan, pale brown (10YR 6/3) dry; many faint dark brown (7.5YR 4/3) mottles, many light gray (10YR 7/2) mottles dry; platy structure; very firm and brittle; weakly cemented; no roots; weakly effervescent; moderately alkaline; clear wavy boundary.

IIC2-31 to 60 inches; dark brown (10YR 4/3) sandy clay loam, very pale brown (10YR 7/3) dry; massive; hard, friable, slightly sticky and slightly plastic; no roots; many very fine pores; moderately alkaline.

The duripan is at a depth of 20 to 35 inches. The duripan does not have an indurated, continuous opal cap or indurated subhorizon, and dry fragments do not completely slake in water with prolonged wetting.

The A horizon has value of 2 or 3, moist. The B2t horizon has value of 2 to 4, moist and 5 or 6, dry and chroma of 1 to 3, moist and 1 or 2, dry. It is clay loam and clay. The Bt horizon has 35 to 50 percent clay.

Bly series

The Bly series consists of very deep, well drained soils on terraces. These soils formed in alluvial and lacustrine sediment that has a small amount of ash. Slopes are 0 to 8 percent. The mean annual precipitation is about 17 inches, and the mean annual air temperature is 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F. The soil generally is moist, but it is dry at depths between 4 and 12 inches for 65 to 90 days following June 21.

Typical pedon of Bly loam, 0 to 2 percent slopes, in an area of woodland, about 1 mile south of the town of

Sprague River, 200 feet south of the northwest corner sec. 23, T. 36 S., R. 10 E.:

A1-0 to 2 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 5/3) dry; weak thin platy structure parting to .weak very fine granular; soft, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; slightly acid; clear smooth boundary.

A3-2 to 11 inches; very dark grayish brown (10YR 3/2) heavy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; common very fine and few medium roots; common very fine tubular pores; neutral; clear wavy boundary.

B21t-11 to 22 inches; dark brown (10YR 3/3) gravelly clay loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and few medium roots; many very fine tubular pores; common moderately thick clay films on peds and pebbles and few thin clay films in pores; slightly acid; clear wavy boundary.

B22t-22 to 35 inches; dark brown (10YR 4/3) gravelly clay loam, light yellowish brown (10YR 6/4) dry, dark yellowish brown (10YR 4/4) crushed; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and few medium roots; many very fine tubular pores; many moderately thick clay films on peds and pebbles and thin clay films in pores; slightly acid; gradual wavy boundary.

B3t-35 to 60 inches; dark brown (10YR 3/3) clay loam, light yellowish brown (10YR 6/4) dry, dark brown (10YR 4/3) crushed; weak medium subangular blocky structure; hard, firm, sticky and plastic; common very fine and few medium roots; many very fine tubular pores; common moderately thick clay films on peds and thin clay films in pores; slightly acid.

Bedrock is at a depth of more than 60 inches. The mollic epipedon is 20 to 30 inches thick.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 2 or 3, moist and dry. It has 0 to 15 percent pebbles. The Bt horizon has hue of 10YR and 7.5YR; value of 3 or 4, moist and 5 or 6, dry; and chroma of 3 or 4, moist and 2 to 4, dry. It has 27 to 35 percent clay, 10 to 25 percent pebbles, and 0 to 10 percent cobbles.

Calder series

The Calder series consists of shallow, moderately well drained soils on low terraces. These soils formed in lacustrine sediment weathered from lava rock, diatomite, and a small amount of ash. Slopes are 0 to 1 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 47 degrees F. The mean annual soil temperature is 47 to 50 degrees F. The soil generally is moist, but it is dry at depths of between 4 and 12 inches for about 70 to 100 consecutive days during the 4-month period following June 21.

Typical pedon of Calder silt loam, in an area of rangeland, in Swan Lake Valley, 2,480 feet west and 1,950 feet south of the northeast corner sec. 5, T. 38 S., R. 10 E.:

A1-0 to 5 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry, very dark grayish brown (10YR 3/2) crushed; weak very thin platy structure; hard, friable, slightly sticky and nonplastic; common very fine roots; many very fine vesicular pores; neutral; abrupt smooth boundary.

A2-5 to 8 inches; dark grayish brown (10YR 4/3) silty clay loam, light gray (10YR 7/1) dry; weak thin platy structure; hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; neutral; abrupt wavy boundary.

B2t-8 to 14 inches; dark brown (7.5YR 4/3) clay, brown (10YR 5/3) dry, dark brown (7.5YR 3.3) crushed; moderate medium and fine columnar structure; very hard, very firm, very sticky and very plastic; common very fine roots; common very fine tubular pores; many moderately thick clay films on peds and thin clay films in pores; coatings of light gray (10YR 7/1) dry, silt on columnar caps and upper surfaces of prisms; neutral; abrupt smooth boundary.

C1sim-14 to 24 inches; dark brown (10YR 4/3) duripan, pale brown (10YR 6/3) and light yellowish brown (10YR 6/4) dry; moderate thin platy structure; very firm, strongly cemented; few very fine roots in upper 3 inches of pan; many very fine discontinuous tubular pores; thin continuous silica coatings on vertical fractures and upper plate surfaces; neutral; clear wavy boundary.

C2sim-24 to 60 inches; dark brown (10YR 4/3) duripan, very pale brown (10YR 7/3) dry; weak platy structure; very firm, weakly cemented; no roots; many very fine discontinuous tubular pores; thin silica coatings on vertical fractures and on top of some plates.

The duripan is at a depth of 12 to 20 inches. It is weakly to strongly cemented.

The A1 horizon has hue of 10YR and 7.5YR; value of 3 or 4, moist; and chroma of 1 or 2, moist and dry. The A2 horizon has chroma of 1 or 2, moist. It is silt loam, silty clay loam, or clay loam and has 18 to 30 percent clay. The B2t horizon has hue of 10YR, 7.5YR, and 2.5Y; value of 3 or 4, moist and 5 or 6, dry; and chroma of 2 to 4, moist and dry. Silt coatings have value of 7, dry. This horizon has 50 to 60 percent clay. Structure is prismatic or columnar. The upper 1 or 2 inches of prisms or columns is coated with light gray silt.

Calimus series

The Calimus series consists of very deep, well drained soils on terraces and alluvial fans. These soils formed in alluvial and lacustrine sediment weathered from diatomite, tuff, and basalt. Slopes are 0 to 35 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 53 degrees F. The soil generally is dry, and it is dry at depths of between 4 and 12 inches for about 80 to 120 days in the 4-month period following June 21.

Typical pedon of Calimus loam, 2 to 5 percent slopes, in an area of irrigated cropland, about 11 miles south and 5 miles west of Klamath Falls, 1,300 feet east and 1,000 feet south of the northwest corner sec. 27, T. 40 S., R. 8 E.:

Ap-0 to 8 inches; very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) dry; weak thin platy structure parting to weak very fine granular; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; neutral; abrupt smooth boundary.

A12-8 to 14 inches; very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; neutral; gradual smooth boundary.

B1-14 to 22 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; neutral; gradual smooth boundary.

B2-22 to 43 inches; very dark grayish brown (10YR 3/2) heavy loam, dark grayish brown (10YR 4/2) dry, dark brown (10YR 3/3) crushed; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; gradual smooth boundary.

B3-43 to 48 inches; dark brown (10YR 3/3) loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common fine and very fine tubular pores; neutral; gradual wavy boundary.

C-48 to 60 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; neutral.

Bedrock is at a depth of more than 60 inches. The mollic epipedon is 20 to more than 30 inches thick. The 10- to 40-inch control section has 18 to 27 percent clay and 0 to 10 percent pebbles.

The A horizon has value of 2 or 3, moist and 4 or 5, dry; and chroma of 1 or 2, moist and dry. The B horizon has value of 2 to 4, moist and 4 to 6, dry; and chroma of 2 or 3, moist and 1 to 3, dry. It is loam or sandy clay loam. The C horizon is loam, fine sandy loam, and loamy fine sand. It is calcareous in some pedons at a depth of below 44 inches.

Capona series

The Capona series consists of moderately deep, well drained soils on terraces and pediments. These soils formed in material weathered from lava rocks and diatomite. Slopes are 0 to 35 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 53 degrees F. The soil generally is dry; it is dry at depths between 4 and 12 inches for 90 to 120 consecutive days during the 4-month period following June 21.

Typical pedon of Capona loam, 5 to 15 percent slopes, in an area of rangeland, about 4 miles north of the town of Malin, 2,850 feet north and 3,200 feet east of the southwest corner sec. 27, T. 40 S., R. 12 E.:

A1-0 to 5 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak very thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; slightly acid; abrupt smooth boundary.

A3-5 to 11 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few medium roots; common very fine tubular pores; slightly acid; clear smooth boundary.

B1-11 to 18 inches; dark brown (10YR 3/3) gravelly sandy clay loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; common very fine and few fine roots; common very fine tubular pores; neutral; clear smooth boundary.

B2-18 to 25 inches; dark brown (10YR 3/3) gravelly sandy clay loam, brown (10YR 5/3) and pale brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; common fine and few very fine roots; common very fine tubular pores; neutral; abrupt wavy boundary.

R-25 inches; volcanic tuff breccia that contains black, angular, basaltic fragments.

Bedrock is at a depth of 20 to 40 inches. The solum is slightly acid and neutral.

The A horizon has value of 2 or 3, moist and chroma of 2 or 3, moist and dry. It has 0 to 15 percent fine pebbles. The B horizon has value of 5 or 6, dry and chroma of 3 or 4, moist. It is sandy clay loam, clay loam, and loam; 18 to 30 percent clay; 5 to 20 percent pebbles; and 0 to 15 percent cobbles.

Chiloquin series

The Chiloquin series consists of very deep, moderately well drained soils on terraces. These soils formed in mixed alluvium with a small amount of ash. Slopes are 0 to 1 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F. A water table is at a depth of 1 foot to 3 feet for about 100 days in spring and summer, but the soil is dry for about 60 consecutive days at depths between 4 and 12 inches during the 4-month period following June 21.

Typical pedon of Chiloquin loam, in a cultivated field, about 4 miles west of the village of Sprague River, 1,950 feet south and 30 feet west of the northeast corner sec. 6, T. 36 S., R. 10 E.:

Ap-0 to 5 inches; very dark brown (10YR 2/2) loam, gray (10YR 5/1) dry; weak very thin platy structure parting to weak very fine granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine and fine vesicular pores; 15 percent ash; neutral; abrupt wavy boundary.

A3-5 to 18 inches; very dark grayish brown (10YR 3/2) heavy loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure parting to weak very fine granular; slightly hard, friable, sticky and slightly plastic; common very fine roots; many very fine tubular pores; 15 percent ash; neutral; abrupt smooth boundary.

IIB2-18 to 28 inches; dark brown (10YR 3/3) heavy loam; light brownish gray (10YR 6/2) dry; weak medium and fine angular blocky structure; hard, friable, sticky and slightly plastic; common very fine roots; many very fine and common fine tubular pores; neutral; clear wavy boundary.

IIC1-28 to 43 inches; dark brown (10YR 3/3) loam, pale brown (10YR 6/3) dry; massive; hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine and common fine tubular pores; few dark gray coatings in pores; few black concretions or pellets; neutral; gradual wavy boundary.

IIC2-43 to 60 inches; dark yellowish brown (10YR 3/4) loam, pale brown (10YR 6/3) dry; common fine and few medium dark brown (7.5YR 3/3) mottles; massive; hard, friable, slightly sticky and slightly plastic; few roots; many very fine, common fine, and few medium tubular pores; mildly alkaline.

The mollic epipedon is 7 to 20 inches thick. The 10- to 40-inch control section has 18 to 30 percent clay.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 2, moist and 1 or 2, dry. It has 10 to 30 percent pumiceous ash dominantly 1 to 2 millimeters thick. It is loam and sandy loam. The IIB horizon has value of 3 or 4, moist and 5 or 6, dry and chroma of 2 or 3, moist and 1 or 2, dry. It is loam, clay loam, or sandy clay loam. The IIC horizon has value of 3 or 4, moist and 6 or 7, dry and chroma of 2 to 4, moist and 1 to 3, dry. It commonly is mottled at depths below 43 inches. This horizon is loam, clay loam, and sandy clay loam.

Chock series

The Chock series consists of very deep, poorly drained soils on flood plains. These soils formed in alluvium that consists of pumiceous ash. Slopes are 0 to 1 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 43 degrees F. The mean annual soil temperature is 44 to 46 degrees F, and the summer soil temperature is 55 to 59 degrees F. A water table is at a depth of 1 foot to 2.5 feet.

Typical pedon of Chock loam, in an area of irrigated meadow, about 3 miles south of the town of Fort Klamath, 2,100 feet north and 850 feet east of the southwest corner sec. 34, T. 33 S., R. 7 1/2 E.:

A1-0 to 7 inches; black (10YR 2/1) loam, gray (N 6/) dry; massive; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; few pumice cinders; neutral; clear smooth boundary.

AC-7 to 17 inches; very dark gray (10YR 3/1) light loam, gray (N 6/) dry; common fine distinct dark brown and dark reddish brown mottles; massive; soft, very friable, slightly sticky and nonplastic; many very fine roots to a depth of 10 inches, few roots to a depth of 17 inches; many very fine pores; many fine pumice cinders; neutral; gradual smooth boundary.

C-17 to 60 inches; dark gray (N 4/) loam, light gray (N 7/) dry; common fine distinct dark yellowish brown mottles; massive; soft, very friable, slightly sticky and nonplastic; few very fine roots; many very fine pores; many fine cinders; neutral.

Mineralogy of the profile is medial with more than 60 percent vitric volcanic ash and cinders from pumice. Estimated bulk density of the fine earth fraction is 0.4 to 0.6 gram per cubic centimeter. The 10- to 40-inch control section has 8 to 15 percent clay and 15 to 35 percent cinders 2 to 10 millimeters thick. The soil is neutral to moderately alkaline.

The A horizon has value of 2 or 3, moist and 6, dry and chroma of 0 or 1, moist and dry. It has 5 to 20 percent cinders 2 to 10 millimeters thick. The C horizon has value of 3 to 5, moist and 6 or 7, dry and chroma of 0 or 1, moist and dry.

Choptie series

The Choptie series consists of shallow, well drained soils on low hills. These soils formed in material weathered mainly from tuff. Slopes are 2 to 30 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F. The soil generally is moist, but it is dry at depths of between 8 inches and the lithic contact for about 80 to 90 days during the 4-month period following June 21.

Typical pedon of Choptie loam, 2 to 30 percent slopes, in an area of idle land, about 1 mile southwest of the town of Beatty, center of the SE1/4SW1/4 sec. 22, T. 36 S., R. 12 E.:

A11-0 to 3 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate very fine granular structure; soft, very friable, slightly sticky and nonplastic; no roots; many very fine vesicular pores; neutral; abrupt smooth boundary.

A12-3 to 6 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak thick platy structure parting to moderate very fine granular; soft, very friable, slightly sticky and nonplastic; many very fine roots; many very fine tubular pores; neutral; gradual smooth boundary.

B2-6 to 16 inches; dark brown (10YR 3/3) loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine tubular pores; neutral; abrupt irregular boundary.

IIR-16 inches; white (10YR 8/1), black (10YR 2/1), and pink (7.5YR 7/4) pumice tuff with angular fragments of pumice.

Bedrock is at a depth of 12 to 20 inches.

The solum has 0 to 10 percent hard lava rock fragments 2 to 5 millimeters thick and 5 to 20 percent weathered cinders or other soft pebbles. The solum is neutral or slightly acid.

The A horizon has value of 2 or 3, moist. The B2 horizon has value of 3 or 4, moist and 5 or 6, dry and chroma of 2 or 3, moist and dry. It is loam or fine sandy loam and has 12 to 18 percent clay. The bedrock is extremely hard pumice tuff, tuffaceous breccia, and tuffaceous sandstone.

Collier series

The Collier series consists of very deep, excessively drained soils on terraces. These soils formed in very gravelly alluvium weathered from lava rocks. Slopes are 0 to 3 percent. The mean annual precipitation is about 25 inches, and the mean annual air temperature is about 43 degrees F. The mean annual soil temperature is 42 to 45 degrees F, and the mean summer soil temperature without an O horizon is 52 to 59 degrees F.

Typical pedon of Collier loamy sand, in an area of conifer forest, about 4 miles northwest of the town of Fort Klamath, 2,700 feet north and 1,900 feet west of the southeast corner sec. 31, T. 32 S., R. 7 1/2 E.:

A11-0 to 7 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine pores; 15 percent pebbles; slightly acid; gradual smooth boundary.

A12-7 to 14 inches; very dark brown (10YR 2/2) gravelly loamy sand, dark gray (10YR 4/1) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine pores; 20 percent pebbles; slightly acid; gradual wavy boundary.

C1-14 to 19 inches; very dark grayish brown (10YR 3/2) very gravelly sand, grayish brown (10YR 5/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine pores; 40 percent pebbles; slightly acid; gradual wavy boundary.

C2-19 to 65 inches; very dark grayish brown (10YR 3/2) very gravelly sand, grayish brown (10YR 5/2) dry; single grain; loose when dry and moist; common very fine roots to a depth of 35 inches, few roots to a depth of 65 inches; many very fine pores; 55 percent pebbles; slightly acid.

Mineralogy of the soil is mixed; the soil has 10 to 30 percent pumiceous ash and 10 to 30 percent cinders. Cinders are pumice and black and red scoria. The 10- to 40-inch control section has 35 to 50 percent hard lava pebbles and cinders. The mollic epipedon is 10 to 16 inches thick. Sand grains below 16 inches have a high proportion of uncoated mafic minerals.

The A horizon has chroma of 1 to 2, moist and dry. It has 5 to 20 percent pebbles. The C horizon has value of 3 or 4, moist and chroma of 2 or 3, moist and dry.

Crume series

The Crume series consists of deep, well drained soils on terraces. These soils formed in alluvial and lacustrine sediment weathered mainly from diatomite, tuff, and ash. Slopes are 0 to 8 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F. The soil generally is moist, but it is dry for 65 to 90 days at depths between 4 and 12 inches during the 4-month period following June 21.

Typical pedon of Crume loam, 0 to 2 percent slopes, in an area of rangeland, about 4 miles northwest of the town of Sprague River, 800 feet east and 2,650 feet south of the northwest corner sec. 29, T. 35 S., R. 10 E.:

A11-0 to 4 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak very thin platy structure parting to weak very fine granular; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; 5 percent pebbles; 20 percent pumice ash; neutral; clear wavy boundary.

A12-4 to 9 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; 5 percent pebbles; 20 percent ash; neutral; gradual wavy boundary.

A3-9 to 15 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; many very fine roots; common very fine tubular pores; 5 percent pebbles; 15 percent pumice ash; neutral; gradual wavy boundary.

B1-15 to 19 inches; very dark grayish brown (10YR 3/2) clay loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; thin clay coatings on coarse sand grains; 10 percent pebbles; about 15 percent pumice ash; neutral; gradual wavy boundary.

B2-19 to 27 inches; dark brown (10YR 3/3) clay loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; common very fine tubular pores; few thin clay bridges between sand grains; 10 percent pebbles; 10 percent pumice ash; neutral; gradual wavy boundary.

B3-27 to 34 inches; dark brown (10YR 3/3) clay loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; hard, friable, sticky and slightly plastic; common very fine roots; common very fine and few medium tubular pores; thin clay bridges between sand grains; 10 percent pebbles; neutral; gradual wavy boundary.

C1-34 to 44 inches; dark brown (10YR 3/3) loam, pale brown (10YR 6/3) dry; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; 10 percent pebbles; neutral; abrupt smooth boundary.

C2r-44 inches; diatomite interceded with lacustrine tuff.

Bedrock is at a depth of 40 to 60 inches. The 10- to 40-inch control section has 0 to 10 percent hard lava pebbles. The mollic epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3, moist and 4 or 5, dry. It has 0 to 20 percent pumice cinders 2 to 4 milllimeters thick, 10 to 30 percent cinders and ash, and 0 to 10 percent fine hard lava pebbles. The B2 horizon has value of 3 or 4, moist and 5 or 6, dry and chroma of 2 or 3, moist and dry. Clay films, where present, are lacking on either vertical or horizontal faces of peds or in fine pores; or an increase in the clay ratio of as much as 1.2 in the B2 horizon is not reached within a vertical distance of 12 inches. This horizon has 0 to 10 percent each of pumice cinders and hard pebbles less than 5 millimeters thick. It is clay loam or sandy clay loam and has 25 to 35 percent clay. Structure is weak and moderate subangular blocky. The C horizon has value of 3 or 4, moist and chroma of 3 or 4, moist. It has 0 to 15 percent hard pebbles less than 5 millimeters thick.

Crume Variant

The Crume Variant consists of deep, well drained soils on the sides of narrow valleys. These soils formed in a thin mantle of pumiceous ash that is underlain by a very gravelly and loamy buried soil. Slopes are 2 to 12 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F.

Typical pedon of Crume Variant sandy loam, 2 to 12 percent slopes, in an area of rangeland, about 4 miles northeast of the town of Beatty, 3,100 feet east and 3,900 feet north of the southwest corner sec. 1, T. 36 S., R. 12 E.:

A11-0 to 7 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; weak very thin platy structure parting to weak very fine granular; soft, very friable, slightly sticky and nonplastic; many very fine roots; many very fine pores; slightly acid; clear wavy boundary.

A12-7 to 16 inches; very dark grayish brown (10YR 3/2) gravelly coarse sandy loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure parting to weak very fine granular; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine pores; neutral; clear wavy boundary.

B21-16 to 22 inches; dark brown (10YR 3/3) gravelly coarse sandy loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine roots; common very fine tubular pores; neutral; abrupt smooth boundary.

IIB22b-22 to 30 inches; dark brown (10YR 3/3) very gravelly clay loam, brown (10YR 5/3) dry, dark brown (10YR 4/3) rubbed; moderate medium and coarse subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; common very fine tubular pores; few thin cutans on ped faces; neutral; gradual wavy boundary.

IIB3b-30 to 42 inches; dark brown (10YR 3/3) very gravelly sandy clay loam, pale brown (10YR 6/3) dry; massive; hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; neutral; abrupt irregular boundary.

IICsim-42 to 60 inches; dark brown (10YR 3/3) gravelly duripan, light gray (10YR 7/2) dry; very pale brown (10YR 8/3) opaline laminar cap about 0.5 millimeter thick at top of duripan; indurated.

The solum and duripan are at a depth of 40 to 60 inches. The ashy upper part of the profile is 17 to 30 inches thick and has 50 to 70 percent pumiceous ash. This part of the soil also has 10 to 20 percent hard lava pebbles 2 to 5 millimeters thick. The loamy buried soil has 18 to 30 percent clay and 35 to 50 percent hard lava rock fragments of which 0 to 5 percent are cobbles and stones.

The A horizon has value of 2 or 3, moist and 5, dry. It is sandy loam and coarse sandy loam. The B horizon has value of 3 or 4, moist and 6, dry. Structure is weak, medium, and coarse subangular blocky. The IIB2b horizon has value of 3 or 4, moist and 5 or 6, dry. It is very gravelly and is clay loam, sandy clay loam, or loam. Structure is weak or moderate subangular blocky. In many pedons it has cutans on ped faces and thin clay bridges between sand grains. The duripan commonly is weakly to strongly cemented.

Dehlinger series

The Dehlinger series consists of very deep, well drained soils on escarpments. These soils formed in very gravelly colluvium weathered from basalt, tuff, and andesite. Slopes are 15 to 65 percent. The mean annual precipitation is about 14 inches, and the mean annual air temperature is about 47 degrees F. The mean annual soil temperature is 47 to 54 degrees F. The soil generally is dry, and it is dry at depths between 4 and 12 inches for 90 to 120 consecutive days in the 4-month period following June 21.

Typical pedon of Dehlinger very stony loam, 15 to 65 percent south slopes, in an area of rangeland, about 6 miles south of Klamath Falls on the northwest slope of Stukel Mountain, 2,500 feet west and 310 feet south of the northeast corner sec. 5, T. 40 S., R. 10 E.:

A1-0 to 6 inches; very dark brown (10YR 2/2) very stony loam, grayish brown (10YR 5/2) dry; weak very fine and fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; neutral; clear wavy boundary.

A3-6 to 18 inches; very dark grayish brown (10YR 3/2) extremely gravelly clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; many very fine tubular pores; neutral; clear wavy boundary.

B21-18 to 27 inches; dark brown (10YR 3/3) extremely gravelly clay loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; many very fine tubular pores; neutral; gradual wavy boundary.

B22-27 to 53 inches; dark yellowish brown (10YR 4/4) extremely gravelly clay loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; many very fine tubular pores; mildly alkaline; gradual wavy boundary.

IIB2b-53 to 70 inches; dark yellowish brown (10YR 3/4) extremely gravelly clay loam, yellowish brown (10YR 5/4) dry; moderate fine angular blocky structure; very hard, friable, sticky and plastic; common very fine roots; many very fine tubular pores; few thin clay films or cutans; mildly alkaline.

Bedrock is at a depth of more than 60 inches. The mollic epipedon is 20 to 35 inches thick. Rock fragments in the 10- to 40-inch control section range from 35 to 75 percent with 0 to 25 percent cobbles and stones. The soil is very gravelly and is loam or clay loam and has 18 to 30 percent clay. It is neutral and mildly alkaline.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 2, moist and 1 or 2, dry. It has 10 to 35 percent pebbles and 5 to 15 percent cobbles and stones. The B horizon has value of 3 or 4, moist and 4 to 6, dry and chroma of 2 to 4, moist and dry.

Deter series

The Deter series consists of very deep, well drained soils on terraces. These soils formed in clayey sediment weathered from lava rock and diatomite. Slopes are 0 to 7 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 53 degrees F. The soil generally is moist, but it is dry at depths between 4 and 12 inches for 80 to 110 days in the 4-month period following June 21.

Typical pedon of Deter clay loam, 0 to 2 percent slopes, in a cultivated field, about 12 miles southwest of Klamath Falls, 1,240 feet east and 120 feet south of the northwest corner sec. 17, T. 40 S., R. 8 E.:

Ap-0 to 8 inches; very dark brown (10YR 2/2) clay loam, dark gray (10YR 4/1) dry; weak thin platy structure parting to very fine granular; hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; neutral; abrupt smooth boundary.

B1t-8 to 12 inches; very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; weak medium platy structure; hard, firm, very sticky and plastic; common very fine roots; common very fine tubular pores; many thin clay films in pores and on peds; neutral; clear smooth boundary.

B2t-12 to 35 inches; very dark grayish brown (10YR 3/2) clay, dark grayish brown (10YR 4/2) dry, dark brown (10YR 3/3) crushed; moderate medium prismatic structure; very hard, very firm, very sticky and very plastic; common very fine roots; common very fine tubular pores; continuous stress cutans on peds and thin clay films in pores; neutral; gradual wavy boundary.

B3t-35 to 60 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry, dark brown (10YR 3/3) crushed; moderate fine and medium angular blocky structure; hard, firm, very sticky and plastic; common very fine roots; many very fine tubular pores; many moderately thick clay films on peds and thin clay films in pores; mildly alkaline.

Bedrock is at a depth of more than 60 inches. The mollic epipedon is 20 to more than 30 inches thick. Rock fragments commonly are lacking, but some profiles have as much as 10 percent pebbles.

The A horizon has hue of 10YR or 7.5YR; value of 2 or 3, moist and 4 or 5, dry; and chroma of 1 or 2, moist and dry. The A horizon is slightly acid or neutral. The B horizon has hue of 5YR to 10YR; value of 2 to 4, moist and 4 to 6, dry; and chroma of 2 to 4, moist and dry. It is clay loam and clay and has 35 to 45 percent clay. The B horizon is neutral to moderately alkaline.

Dilman series

The Dilman series consists of very deep, poorly drained soils on flood plains. These soils formed in mixed alluvium over a layer of ash. Slopes are 0 to 1 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F, and the mean summer soil temperature is 56 to 59 degrees F. The soil is saturated, and a water table is present in spring and early in summer.

Typical pedon of Dilman silty clay loam, in an area of pasture, about 2 miles east of the town of Bly, 1,750 feet east and 400 feet north of the southwest corner sec. 31, T. 36 S., R. 15 E.:

A11-0 to 3 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak thin platy structure parting to moderate very fine granular; slightly hard, friable, very sticky and plastic; many very fine roots; common very fine tubular pores; neutral; abrupt wavy boundary.

A12-3 to 13 inches; black (N 2/) clay, dark gray (N 4/) dry; moderate medium prismatic structure; hard, firm, very sticky and very plastic; many very fine roots; common very fine tubular pores; many cutans on peds; neutral; clear wavy boundary.

B2-13 to 21 inches; very dark gray (10YR 3/1) clay loam, gray (2.5Y 5/1) dry, light gray (2.5Y 6/1) rubbed and dry; common fine distinct light olive brown (2.5Y 5/4) mottles, dry; weak medium prismatic structure parting to weak medium angular blocky; very hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; many cutans on peds; 40 percent ash; neutral; gradual wavy boundary.

B3-21 to 28 inches; very dark gray (10YR 3/1) sandy clay loam, gray (10YR 6/1) dry; many fine distinct light olive brown (2.5Y 5/4) mottles, dry; many fine black coatings on peds; weak medium angular blocky structure; very hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; 50 percent ash; mildly alkaline; gradual wavy boundary.

IIC1-28 to 37 inches; very dark grayish brown (10YR 3/2) sandy clay loam, light gray (10YR 7/2) dry; many fine and medium distinct dark brown (7.5YR 3/4) mottles; massive; slightly hard, friable, sticky and slightly plastic; common very fine roots; many very fine tubular pores; 60 percent ash; mildly alkaline; clear wavy boundary.

IIC2-37 to 50 inches; grayish brown (10YR 5/2) and light gray (10YR 7/2) coarse sand, light gray (10YR 7/1) and white (N 8/) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine tubular pores; 80 percent ash; mildly alkaline; abrupt smooth boundary.

IIIC3-50 to 60 inches; dark brown (7.5YR 4/3) clay loam, brown (7.5YR 5/3) dry; many reddish gray (5YR 5/2) seams and threads; moderate fine angular blocky structure; very hard, very firm, very sticky and very plastic; common very fine roots; common very fine tubular pores; effervescent in seams and threads; neutral.

The mollic epipedon is 7 to 20 inches thick.

The A horizon has value of 2 or 3, moist and 3 to 5, dry and chroma of 0 or 1, moist and dry. It commonly is silty clay loam, but the range includes clay loam, silt loam, and clay. It has as much as 30 percent pumiceous ash. The B horizon matrix has hue of neutral, 10YR, and 2.5Y; value of 3 or 4, moist and 5 or 6, dry; and chroma of 0 or 1, moist and dry. It is silty clay loam, clay loam, and sandy clay loam. It has 25 to 35 percent clay and as much as 50 percent ash. Uncoated grains have value of 3 to 6 and chroma of 3 or 4, moist. The IIC horizon has hue of neutral, 10YR, and 2.5Y; value of 3 to 7, moist and 6 to 8, dry; and chroma of 0 to 2, moist and dry. It predominantly is pumiceous ash and is loamy coarse sand or coarse sand in some part at a depth of 20 to 40 inches. It is 0 to 15 percent cinders 2 to 5 millimeters thick.

Dodes series

The Dodes series consists of moderately deep, well drained soils on pediments and terraces. These soils formed in material weathered mainly from tuff. Slopes are 0 to 15 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 to 53 degrees F. The soil profile generally is dry, and it is dry at depths between 4 and 12 inches for 100 to 120 consecutive days in the 4-month period following June 21.

Typical pedon of Dodes loam, 2 to 5 percent slopes, in a cultivated field, about 8 miles southeast of Klamath Falls, 750 feet east and 30 feet north of the southwest corner sec. 17, T. 39 S., R. 10 E.:

Ap-0 to 7 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; weak thin platy structure parting to moderate very fine granular; soft, very friable, slightly sticky and slightly plastic; common fine and very fine roots; many very fine pores; neutral; abrupt smooth boundary.

A3-7 to 12 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure parting to weak very fine granular; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; many very fine tubular pores; neutral; clear wavy boundary.

B21t-12 to 15 inches; very dark grayish brown (10YR 3/2) clay loam, dark brown (10YR 4/3) dry, brown (10YR 5/3) rubbed and dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; common fine and very fine roots; many very fine tubular pores; few thin clay films on peds, many thin clay films in pores, and thin clay bridges between sand grains; slightly acid; clear wavy boundary.

B22t-15 to 22 inches; dark brown (10YR 3/3) clay loam, brown (10YR 5/3) dry, pale brown (10YR 6/3) rubbed and dry; weak medium subangular blocky structure; very hard, firm, very sticky and plastic; common fine and very fine roots; many very fine tubular pores; few thin clay films on peds and in pores and thin clay bridges between sand grains; slightly acid; abrupt wavy boundary.

IICr-22 to 29 inches; black (N 2/) partially weathered sandy tuff interbedded with brown (10YR 5/3) diatomite.

Bedrock is at a depth of 20 to 40 inches. The mollic epipedon is 7 to 20 inches thick. The Bt horizon has 5 to 30 percent hard lava pebbles and 10 to 30 percent soft weathered tuffaceous and diatomaceous pebbles. The solum is neutral and slightly acid.

The A horizon has value of 2 or 3, moist and 4 or 5, dry. The B2t horizon has value of 4 to 6, dry and chroma of 2 or 3, moist and dry. The Bt horizon is clay loam and sandy clay loam, has 25 to 35 percent clay, and has 35 to 50 percent particles that are coarser than very fine sand.

Fordney series

The Fordney series consists of very deep, excessively drained soils on terraces. These soils formed in alluvial and lacustrine sediment weathered mainly from tuff. Slopes are 0 to 20 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 53 degrees F. The soil generally is dry, and it is dry at depths between 12 and 35 inches for 80 to 120 days during the 4-month period following June 21.

Typical pedon of Fordney loamy fine sand, 0 to 2 percent slopes, in a cultivated field, about 2 miles north of the town of Malin, 1,320 feet south of the center corner sec. 3, T. 41 S., R. 12 E.:

Ap-0 to 8 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine and few fine roots; many very fine pores; neutral; abrupt smooth boundary.

C1-8 to 48 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and few fine roots; many very fine pores; neutral; diffuse smooth boundary.

C2-48 to 60 inches; very dark grayish brown (2.5Y 3/2) loamy sand, grayish brown (10YR 5/2) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine pores; neutral.

Mineralogy of the soil is mixed but includes a high percentage of mafic minerals. Sand grains mainly are not coated by organic matter at depths below about 10 inches. Bedrock is at a depth of more than 60 inches.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 1 or 2, dry. The C horizon has hue of 10YR and 2.5Y, value of 3 to 5, moist and 4 to 6, dry and chroma of 2 or 3, moist and dry. It is loamy sand, loamy fine sand, and sand and has 0 to 5 percent pebbles 2 to 5 millimeters thick.

Fuego series

The Fuego series consists of moderately deep, somewhat excessively drained soils on volcanic hills. These soils formed in very gravelly material weathered from felsitic rocks. Slopes are 5 to 40 percent. The mean annual precipitation is about 17 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F. The soil generally is moist, but it is dry at depths between 8 and 24 inches for 65 to 90 days during the 4-month period following June 21.

Typical pedon of the Fuego very stony sandy loam, 5 to 40 percent slopes, in an area of rangeland, on the south slope of Council Butte, 2,200 feet west and 1,220 feet south of the northeast corner sec. 15, T. 36 S., R. 11 E.:

A11-0 to 5 inches; very dark grayish brown (10YR 3/2) very stony sandy loam, grayish brown (10YR 5/2) dry; weak very thin platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine vesicular pores to a depth of 1 inch and many very fine pores to a depth of 5 inches; neutral; clear smooth boundary.

A12-5 to 10 inches; very dark grayish brown (10YR 3/2) very gravelly sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine pores; neutral gradual wavy boundary.

B2-10 to 25 inches; dark brown (10YR 3/3) very gravelly sandy loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and few fine and medium roots; many very fine pores; neutral; abrupt irregular boundary.

R-25 inches; unweathered andesitic bedrock.

Unweathered bedrock is at a depth of 20 to 40 inches. The section between 10 inches and bedrock has 12 to 18 percent clay and 35 to 60 percent hard lava rock fragments. Mineralogy of the soil is mixed and includes 5 to 30 percent pumiceous ash. The soil is slightly acid or neutral in the upper part and neutral or mildly alkaline in the lower part. The mollic epipedon is 7 to 20 inches thick.

The A horizon has chroma of 2 or 3, moist. The B horizon has hue of 10YR or 7.5YR, value of 3 or 4, moist and 5 or 6, dry and chroma of 2 or 4, moist. It has 0 to 10 percent cobbles and stones and 35 to 50 percent pebbles.

Harriman series

The Harriman series consists of deep, well drained soils on terraces. These soils formed in lacustrine sediment weathered from diatomite and lava rocks. Slopes are 0 to 35 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 53 degrees F. The soil generally is dry, and it is dry at depths between 4 and 12 inches for 80 to 120 days during the 4-month period following June 21.

Typical pedon of Harriman loam, 2 to 5 percent slopes, in an irrigated field, about 3 miles southwest of Klamath Falls, 1,500 feet east and 2,100 feet north of the southwest corner sec. 13, T. 39 S., R. 8 E.:

Ap-0 to 5 inches; very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) dry; weak medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; neutral; abrupt smooth boundary.

A3-5 to 18 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine and few fine and medium tubular pores; weak tillage pan at a depth between 5 and 8 inches; neutral; gradual wavy boundary.

B1t-18 to 28 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry, dark brown (10YR 3/3) crushed; weak medium and fine subangular blocky structure; hard, friable, sticky and slightly plastic; common very fine roots; many very fine and few fine tubular pores; few thin clay films on peds and in pores; neutral; clear wavy boundary.

B2t-28 to 42 inches; dark brown (10YR 3/3) clay loam, brown (10YR 5/3) dry, dark brown (10YR 4/3) crushed; weak medium prismatic structure parting to moderate medium and fine angular blocky; hard, firm, sticky and plastic; common very fine roots; many very fine and few fine tubular pores; few thin clay films on peds and in pores; neutral; gradual wavy boundary.

B3t-42 to 48 inches; dark brown (10YR 3/3) sandy clay loam, pale brown (10YR 6/3) dry, dark brown (10YR 4/3) crushed; weak fine and medium subangular blocky structure; hard, friable, sticky and slightly plastic; common very fine roots; many very fine tubular pores; few thin clay films in pores; neutral; abrupt wavy boundary.

IICr-48 to 52 inches; light brownish gray (10YR 6/2) lacustrine tuff, light gray (10YR 7/2) dry; laminated; extremely firm; weakly effervescent; mildly alkaline.

Bedrock is at a depth of 40 to 60 inches. Mineralogy of the solum is mixed and includes much diatomaceous material. The mollic epipedon is 20 to more than 30 inches thick. The solum is neutral in the upper part and neutral to moderately alkaline in the lower part.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 1 or 2, dry. It has 0 to 5 percent pebbles. The B2t horizon has value of 3 or 4, moist and 5 or 6, dry and chroma of 2 to 4, moist and 2 or 3, dry. It has 27 to 35 percent clay and 5 to 25 percent pebbles. The Bt or C horizon at a depth below 40 inches

Henley series

The Henley series consists of moderately deep, somewhat poorly drained, sodic soils on low terraces. These soils formed in alluvial and lacustrine sediment. Slopes are 0 to 2 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 50 degrees F. A water table is at a depth of 1 foot to 3.5 feet.

Typical pedon of Henley loam, in a cultivated field, about 1 1/2 miles east of the town of Dairy, 1,900 feet west and 1,600 feet south of the northeast corner sec. 35, T. 38 S., R. 11 1/2 E.:

Apca-0 to 5 inches; dark grayish brown (10YR 4/2) loam, light gray (10YR 7/1) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine pores; strongly effervescent; strongly alkaline; clear smooth boundary.

A12ca-5 to 11 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) dry; weak coarse prismatic structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; strongly effervescent; strongly alkaline; clear smooth boundary.

B21ca-11 to 20 inches; dark brown (10YR 4/3) loam, light gray (10YR 7/2) dry; weak coarse prismatic structure parting to weak medium subangular blocky; hard, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; strongly effervescent; strongly alkaline; clear smooth boundary.

B22ca-20 to 25 inches; dark brown (10YR 4/3) fine sandy loam, light gray (10YR 7/2) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; few very fine roots; few very fine tubular pores; strongly effervescent; strongly alkaline; clear wavy boundary.

B3ca-25 to 36 inches; brown (10YR 5/3) sandy loam, light gray (10YR 7/1) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine tubular pores; firm, weakly cemented aggregates to a depth of 31 inches; strongly effervescent; moderately alkaline; abrupt smooth boundary.

IICsim-36 to 60 inches; dark grayish brown (10YR 4/2) duripan; platy; indurated; continuous opaline laminar cap at top of duripan; strongly effervescent; moderately alkaline.

Exchangeable sodium exceeds 15 percent in all or part of the upper 20 inches of the profile, decreasing at a depth of below 20 inches. The A horizon is strongly alkaline or very strongly alkaline; the B horizon and duripan are moderately alkaline or strongly alkaline. The duripan is at a depth of 20 to 40 inches and is 5 to 36 inches thick.

The A horizon has value of 3 or 4, moist and 6 or 7, dry and chroma of 1 or 2, moist and dry. The B horizon has hue of 10YR and 2.5Y; value of 3 to 5, moist and 6 to 8, dry; and chroma of 1 to 3, moist and 1 or 2, dry. It is loam, silt loam, fine sandy loam, and sandy loam and has 18 to 25 percent clay.

Henley Variant

The Henley Variant consists of shallow, somewhat poorly drained, sodic soils on low terraces. These soils formed in alluvial and lacustrine sediment. Slopes are 0 to 2 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 50 degrees F.

Typical pedon of Henley Variant loam, in an area of irrigated pasture, about 2 miles west of the town of Bonanza, 1,600 feet south and 300 feet west of the northeast corner sec. 17, T. 39 S., R. 11 E.:

Ap-0 to 6 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) and grayish brown (10YR 5/2) dry; weak very thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; weakly effervescent; strongly alkaline; clear smooth boundary.

B2-6 to 16 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) and grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; weakly effervescent; moderately alkaline; abrupt smooth boundary.,

C1sim-16 to 31 inches; very dark grayish brown (10YR 3/2) duripan, grayish brown (10YR 5/2) and light gray (10YR 7/2) dry; platy; indurated to a depth of 20 inches and strongly cemented to a depth of 31 inches; brown (10YR 5/3) laminar cap about 1 millimeter thick at top of pan; strongly effervescent; strongly alkaline; clear wavy boundary.

C2-31 to 64 inches; brown (10YR 5/3) loam, light gray (10YR 7/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; no roots; many very fine pores; moderately alkaline.

The duripan is at a depth of 10 to 20 inches. The duripan is platy, about 4 inches to 50 inches thick and is indurated in the upper part and strongly cemented in the lower part. Exchangeable sodium exceeds 15 percent in the A horizon or in all parts of the soil above the duripan.

The A horizon has value of 3 or 4, moist and 5 to 7, dry and chroma of 1 or 2, moist and dry. The B2 horizon has value of 3 to 5, moist and 5 to 6, dry and chroma of 1 or 2, moist and dry. It is loam and fine sandy loam and has 18 to 25 percent clay.

Hosley series

The Hosley series consists of moderately deep, somewhat poorly drained, sodic soils on low terraces. These soils formed in alluvial and lacustrine sediment. Slopes are 0 to 1 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 50 degrees F. A water table is at a depth of 1 foot to 3.5 feet.

Typical pedon of Hosley loam, in the industrial park near Washburn Way in Klamath Falls, SW1/4NW1/4SW1/4 sec. 3, T. 39 S., R. 9 E.:

A11-0 to 6 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; strong thin platy structure; hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; weakly effervescent; strongly alkaline; abrupt wavy boundary.

A12-6 to 12 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak thin platy structure; hard, friable, sticky and slightly plastic; common very fine roots; common very fine tubular pores; weakly effervescent; strongly alkaline; clear wavy boundary.

B1-12 to 16 inches; dark brown (10YR 3/3) clay loam, light brownish gray (10YR 6/2) dry; weak medium and fine subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; weakly effervescent; strongly alkaline; clear wavy boundary.

B2t-16 to 26 inches; dark brown (10YR 4/3) clay loam, pale brown (10YR 6/3) dry; weak medium prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, sticky and plastic; common very fine roots; common very fine tubular pores; common moderately thick clay films on ped surfaces and thin clay films in pores; weakly effervescent; strongly alkaline; abrupt wavy boundary.

C1sim-26 to 42 inches; dark brown (10YR 4/3) duripan, light gray (10YR 7/2) dry; platy; indurated to a depth of 28 inches; strongly cemented to a depth of 38 inches, and weakly cemented to a depth of 42 inches; laminar opaline cap about 5 millimeters thick at top of duripan; strongly effervescent; very strongly alkaline; clear wavy boundary.

C2-42 to 62 inches; dark brown (10YR 4/3) loam, massive; slightly sticky and slightly plastic; no roots; many very fine pores; horizon saturated with water; moderately alkaline.

Exchangeable sodium exceeds 15 percent in all or part of the upper 20 inches decreasing with depth below the duripan, and commonly it is at a maximum in the natric horizon. The solum is calcareous in all parts at depths between 10 to 20 inches. The duripan is at a depth of 20 to 40 inches. The duripan is platy and has an indurated laminar cap 1 to 5 millimeters thick and coatings of opal. The lower part of the duripan commonly is weakly cemented.

The A horizon has value of 3 or 4, moist and 5 or 6, dry and chroma of 3 or 4, moist. The A horizon is moderately alkaline to strongly alkaline. The B2t horizon has value of 3 or 4, moist and 5 or 6, dry and chroma of 3 or 4, moist. It has 27 to 35 percent clay. Structure is prismatic and angular or subangular blocky. This horizon has thin to moderately thick clay films on peds. The B2t horizon is strongly alkaline to very strongly alkaline.

Kirk series

The Kirk series consists of very deep, poorly drained soils on flood plains. These soils formed in alluvium that consists of pumiceous cinders and ash. Slopes are 0 to 1 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 43 degrees F. The mean annual soil temperature is 44 to 46 degrees F, and the mean annual summer soil temperature is 55 to 59 degrees F. A water table is at a depth of 1 foot to 3 feet.

Typical pedon of Kirk loam, in an area of irrigated pasture, about 1 /4 mile west of the town of Fort Klamath, 1,750 feet west and 200 feet south of the northeast corner sec. 21, T. 33 S., R. 7 1/2 E.:

A11-0 to 1 1/2 inches; very dark gray (10YR 3/1) loam dominantly very fine roots, gray (N 5/) dry; massive; soft, very friable, nonsticky and nonplastic; neutral; abrupt smooth boundary.

A12-1 1/2 to 5 inches; black (10YR 2/1) loam, gray (N 5/) dry; weak thin platy structure parting to weak very fine granular; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 5 percent cinders; neutral; clear smooth boundary.

A13-5 to 9 inches; very dark brown (10YR 2/2) loam, gray (2.5Y 5/1) dry; weak medium subangular blocky structure parting to weak very fine granular; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 5 percent cinders; slightly acid; gradual smooth boundary.

AC-9 to 15 inches; very dark gray (10YR 3/1) sandy loam, gray (10YR 6/1) dry; massive; soft, very friable, slightly sticky and nonplastic; common very fine roots; many very fine pores; 15 percent cinders; slightly acid; gradual smooth boundary.

C-15 to 60 inches; very dark gray (10YR 3/1) very gravelly loamy sand, gray (10YR 6/1) dry; many dark grayish brown (10YR 4/2) mottles; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine pores; 50 percent cinders; neutral.

The mineral fraction is pumiceous ash and cinders. The cindery layer is at a depth of 14 to 38 inches. The solum commonly is neutral to slightly acid but ranges to very strongly alkaline in the surface horizon.

The A1 horizon has hue of 10YR, neutral, and 2.5Y; value of 2 or 3, moist and 4 or 5, dry; and chroma of 1 or 2, moist and 0 to 1, dry. The A horizon has 5 to 35 percent cinders of pebble size. The AC horizon has value of 3 or 4, moist and 5 or 6, dry and chroma of 0 or 1, moist and 1 or 2, dry. It is sandy loam and loamy sand or gravelly coarse sandy loam. The C horizon has value of 3 to 6, moist and 6 to 8, dry and chroma of 1 to 4, moist and 2 or 3, dry. It is very gravelly and is loamy sand, sand, and coarse sand, or loamy coarse sand. The C horizon has 30 to 50 percent cinders of pebble size and 5 to 25 percent cinders of cobble size.

Klamath series

The Klamath series consists of very deep, poorly drained soils on flood plains. These soils formed in alluvium weathered mainly from diatomite. Slopes are 0 to 1 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F, and the mean summer soil temperature is 56 to 59 degrees F. A water table is at a depth of 0 to 3 feet in spring.

Typical pedon of Klamath silty clay loam, in an area of native meadow, about 1 /8 mile northeast of Council Butte, 2,100 feet north and 1,800 feet west of the southeast corner sec. 10, T. 36 S., R. 11 E.:

A11-0 to 3 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak very thin platy structure parting to moderate very fine granular; slightly hard, friable, sticky and plastic; many very fine roots; many very fine pores; neutral; abrupt wavy boundary.

A12-3 to 6 inches; black (10YR 2/1) silty clay, gray (10YR 5/1) dry; moderate very thin platy structure parting to moderate very fine granular; slightly hard, friable, sticky and plastic; many very fine roots and tubular pores; neutral; clear wavy boundary.

A13-6 to 11 inches; black (10YR 2/1) silty clay, gray (N 5/) dry; weak thin platy structure parting to moderate very fine angular blocky; hard, firm, very sticky and plastic; common very fine roots; many very fine tubular pores; neutral; clear wavy boundary.

B2-11 to 28 inches; black (10YR 2/1) silty clay, gray (N 5/) dry; weak medium prismatic structure parting to moderate fine subangular blocky; very hard, firm, very sticky and plastic; common very fine roots; many very fine tubular pores; neutral; gradual wavy boundary.

C1-28 to 42 inches; dark gray (10YR 4/1) and very dark gray (10YR 3/1) silty clay, light gray (10YR 7/1) dry; many fine gray and dark brown mottles; massive; very hard, firm, sticky and plastic; few very fine roots; many very fine and medium tubular pores; neutral; gradual wavy boundary.

C2-42 to 51 inches; dark grayish brown (10YR 4/2) silty clay, light gray (10YR 7/1) dry; many medium faint very dark gray (N 3/) and fine distinct dark brown mottles; massive; very hard, firm, sticky and plastic; few very fine roots; many very fine and medium tubular pores; neutral; abrupt smooth boundary.

C3-51 to 60 inches; dark gray (10YR 4/1) silty clay loam, light gray (10YR 7/1) dry; many fine and medium distinct olive brown (2.5Y 4/4) mottles; moderate fine angular blocky structure; very hard, firm, sticky and plastic; few very fine roots; few very fine tubular pores; neutral.

The mollic epipedon ranges from 24 to 40 inches thick. The sand fraction predominantly is ash. The upper part of the profile is neutral and mildly alkaline, and the lower part is neutral to moderately alkaline.

The A horizon has value of 4 or 5, dry and chroma of 0 or 1, moist and dry. The B horizon has value of 2 to 4, moist and 4 to 7,

Klamath Variant

The Klamath Variant consists of very deep, poorly drained, sodic soils on flood plains. These soils formed n mixed alluvium. Slopes are 0 to 1 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F, and the mean summer soil temperature is 56 to 59 degrees F. A water table is at a depth of 0 to 3 feet in spring.

Typical pedon of Klamath Variant clay loam, in an area of native meadow, about 6.6 miles northwest of the town of Sprague River, 1,200 feet west and 10 feet north of the southeast corner sec. 19, T. 35 S., R. 10 E.:

A11-0 to 4 inches; black (10YR 2/1) clay loam, gray (10YR 5/1) dry; weak thin platy structure parting to moderate very fine granular; hard, firm, sticky and plastic; many very fine roots; many very fine pores; weakly effervescent; 15 percent ash; strongly alkaline; clear wavy boundary.

A12-4 to 19 inches; black (10YR 2/1) clay loam, gray (10YR 5/1) dry; moderate medium and fine subangular blocky structure; hard, firm, sticky and plastic; many very fine roots; many very fine and common fine tubular pores; weakly effervescent; 20 percent ash; moderately alkaline; abrupt smooth boundary. B21-19 to 31 inches; very dark gray (10YR 3/1) silty clay loam, light gray (10YR 7/1) dry; moderate fine angular blocky structure; very hard, firm, sticky and plastic; many very fine roots to a depth of 24 inches, common roots to a depth of 35 inches; many tubular pores; few thin cutans on peds; mildly alkaline; clear wavy boundary.

B22-31 to 43 inches; olive brown (2.5Y 4/3) clay loam, pale brown (10YR 6/3) dry; moderate fine and medium angular blocky structure; very hard, firm, sticky and plastic; few very fine roots; many tubular pores; neutral; clear wavy boundary.

C-43 to 60 inches; light olive brown (2.5Y 5/3) gravelly clay loam, pale brown (10YR 6/3) dry; many fine distinct dark brown mottles, common medium and coarse very dark gray (10YR 3/1) mottles; massive; very hard, firm, sticky and plastic; few very fine roots; many tubular pores; 25 percent fine pebbles; neutral.

The 10- to 40-inch control section is clay loam, silty clay loam, and silt loam and has 18 to 35 percent clay. The sand fraction predominantly is pumiceous ash. The upper part of the profile is moderately alkaline or strongly alkaline decreasing to mildly alkaline and neutral. The soil is noncalcareous at a depth below 15

Lakeview series

The Lakeview series consists of very deep, moderately well drained soils on flood plains and alluvial fans. These soils formed in alluvium weathered from lava rocks and a small amount of ash. Slopes are 0 to 2 percent. The mean annual precipitation is about 12 inches, and the mean annual temperature is about 48 degrees F. The mean annual soil temperature is 48 to 50 degrees F. The soil is moist, but it is dry at depths between 4 and 12 inches for 50 to 90 days during the 4-month period

following June 21. A water table is at a depth of 2.5 to 5 feet.

Typical pedon of Lakeview silty clay loam, in a cultivated field, about 7 miles northeast of Klamath Falls, 1,600 feet east and 1,600 feet north of the southwest corner sec. 31, T. 37 S., R. 10 E.:

Ap-0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak thin platy structure parting to moderate very fine granular; slightly hard, friable, sticky and slightly plastic; common very fine roots; many very fine pores; neutral; abrupt smooth boundary.

A12-8 to 14 inches; black (10YR 2/1) silty clay loam, gray (10YR 5/1) dry; weak thick platy structure parting to moderate very fine granular; hard, firm, sticky and plastic; common very fine roots; common very fine tubular pores; neutral; abrupt smooth boundary. A3-14 to 29 inches; black (10YR 2/1) clay loam, gray (10YR 5/1) dry; moderate medium subangular blocky structure parting to moderate very fine granular; hard, firm, sticky and plastic; common very fine roots; common very fine tubular pores; many worm casts; neutral; clear irregular boundary.

B2-29 to 42 inches; dark brown (10YR 3/3) clay loam, pale brown (10YR 6/3) dry; common very dark brown (10YR 2/2) tongues; moderate fine subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few very fine roots; many very fine and common fine tubular pores; neutral; clear wavy boundary.

C-42 to 60 inches; brown (10YR 5/3) silt loam; massive; hard, firm, sticky and slightly plastic; few very fine roots; many very fine and common fine tubular pores; neutral.

The mollic epipedon ranges from 20 to 36 inches in thickness. The 10- to 40-inch control section has 20 to 35 percent clay and more than 15 percent particles that are coarser than very fine sand.

The A horizon has value of 3 to 5, dry and chroma of 0 or 1, moist and dry. It is neutral or mildly alkaline. The B horizon has hue of neutral, 10YR, and 2.5Y; value of 4 to 6, dry; and chroma of 0 to 3, moist and dry. It is clay loam, silty clay loam, or sandy clay loam.

Laki series

The Laki series consists of very deep, moderately well drained soils on terraces. These soils formed in mixed alluvial and lacustrine sediment that has a small amount of ash. Slopes are 0 to 2 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 50 degrees F. The soil generally is moist, but it is dry at depths between 4 and 12 inches for 45 to 70 days in the 4-month period following June 21.

Typical pedon of Laki loam, in a cultivated field, in Poe Valley, 1,280 feet east and 1,930 feet south of the north west corner sec. 31, T. 39 S., R. 11 E.:

Ap-0 to 8 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; weak thin platy structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; few reddish brown and brown fine concretions; weakly effervescent; moderately alkaline; clear smooth boundary.

A12-8 to 15 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; weak medium prismatic structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; weakly effervescent; moderately alkaline; clear smooth boundary.

A3-15 to 19 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few fine flecks and streaks of lime; weakly effervescent; moderately alkaline; clear wavy boundary.

B2-19 to 32 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few grayish brown coatings in pores; few firm aggregates; strongly effervescent; strongly alkaline; gradual wavy boundary.

C1-32 to 48 inches; dark brown (10YR 4/3) loam, light gray (10YR 7/2) dry; massive; soft, very friable, nonsticky and nonplastic; few roots; many very fine tubular pores; few firm aggregates; strongly effervescent; strongly alkaline; clear wavy boundary.

C2-48 to 60 inches; dark grayish brown (10YR 4/2) loam, light gray (10YR 7/1) dry; weak thick platy structure; hard, firm, slightly sticky and nonplastic; no roots; many very fine and fine and few medium tubular pores; strongly effervescent; strongly alkaline.

Bedrock is at a depth of more than 60 inches. A water table is at a depth of 3 to 5 feet from March to September. The mollic epipedon is 10 to 20 inches thick. Depth of sodium saturation is erratic in the profile. The 10- to 40-inch control section is loam or fine sandy loam and has 18 to 25 percent clay.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 1 or 2, moist and dry. It is loam, fine sandy loam, and sandy loam. The B2 horizon has hue of 10YR and 2.5Y; value of 3 or 4, moist and 6 or 7, dry; and chroma of 2 or 3, moist and 1 or 2, dry. The C horizon has hue of neutral, 10YR, and 2.5Y; value of 3 to 5, moist and 6 to 8, dry; and chroma of 1 to 3, moist and 0 to 2, dry.

Laki Variant

The Laki Variant consists of very deep, well drained, sodic soils on beach ridges. These soils formed in calcareous beach deposits. Slopes are 2 to 20 percent. The mean annual precipitation is about 11 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 53 degrees F. The soil generally is dry, and it is dry at depths between 12 and 20 inches for 100 to 120 days during the 4-month period following June 21.

Typical pedon of Laki Variant loam, 2 to 20 percent slopes, in an area of rangeland, about 1 1/2 miles southwest of the town of Merrill, 50 feet north of the State Line Road and 1,320 feet east of the southwest corner sec. 14, T. 41 S., R. 10 E.:

A1-0 to 5 inches; dark brown (10YR 4/3) loam, light brownish gray (10YR 6/2) dry; weak very fine granular structure; soft, very friable, slightly sticky and nonplastic; many very fine roots; many very fine pores; strongly effervescent; strongly alkaline; clear smooth boundary.

C1-5 to 12 inches; dark brown (7.5YR 4/3) clay loam, light gray (10YR 7/2) dry; weak fine subangular blocky structure; soft, friable, slightly sticky and nonplastic; many very fine roots; many very fine pores; strongly effervescent; strongly alkaline; abrupt wavy boundary.

C2-12 to 23 inches; brown (10YR 5/3) clay loam, light gray (10YR 7/2) dry; massive; slightly hard, friable, slightly sticky and nonplastic; many very fine roots; few very fine tubular pores; strongly effervescent; very strongly alkaline; clear wavy boundary.

C3-23 to 33 inches; grayish brown (10YR 5/2) clay loam, light gray (10YR 7/2) dry; massive; soft, very friable, slightly sticky and nonplastic; few very fine roots; few very fine tubular pores; strongly effervescent; very strongly alkaline; gradual smooth boundary.

IIC4-33 to 60 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; strongly effervescent; very strongly alkaline.

Bedrock is at a depth of more than 60 inches. The soil is calcareous, and exchangeable sodium exceeds 15 percent in the profile to a depth of more than 60 inches.

The A horizon has value of 3 or 4, moist and 6 or 7, dry. The C horizon has hue of 10YR or 7.5YR and value of 4 or 5, moist and 6 or 7, dry. It has 18 to 30 percent clay.

Lapine series

The Lapine series consists of deep, excessively drained soils on escarpments, lava tablelands, and cinder cones. These soils formed in air-laid mantles of cinders and ash. Slopes are 1 to 55 percent. The mean annual precipitation is about 25 inches, and the mean annual air temperature is about 43 degrees F. The mean annual soil temperature is 42 to 45 degrees F, and the mean summer soil temperature without an O horizon is 52 to 59 degrees F.

Typical pedon of Lapine gravelly loamy coarse sand, 1 to 10 percent slopes, in an area of mixed conifer wood land, on top of Sugar Hill, 700 feet east and 600 feet north of the southwest corner sec. 24, T. 33 S., R. 7 1/2 E.:

A1-0 to 4 inches; very dark grayish brown (10YR 3/2) gravelly loamy coarse sand, grayish brown (10YR 5/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine pores; 20 percent cinders; slightly acid; clear wavy boundary.

AC1-4 to 9 inches; dark brown (10YR 3/3) gravelly loamy coarse sand, pale brown (10YR 6/3) dry; massive; soft, very friable, nonsticky and nonplastic; many roots; many very fine pores; 30 percent strong brown (7.5YR 5/6) cinders; slightly acid; clear wavy boundary.

AC2-9 to 18 inches; dark brown (10YR 4/3) very gravelly coarse sand; massive; soft, very friable, nonsticky and nonplastic; many roots; many very fine pores; 40 percent strong brown (7.5YR 5/6) cinders; slightly acid; clear wavy boundary.

C1-18 to 25 inches; brown (10YR 5/3) very gravelly coarse sand; massive; soft, very friable; few roots; many very fine pores; 45 percent strong brown (7.5YR 5/6) cinders; slightly acid; clear wavy boundary.

C2-25 to 46 inches; light olive brown (2.5Y 5/4), olive brown (2.5Y 4/4), and dark grayish brown (2.5Y 4/2) extremely gravelly coarse sand; single grain; loose dry and moist; few roots; many very fine pores; 75 percent cinders; neutral; gradual wavy boundary.

C3-46 to 60 inches; light gray (2.5Y 7/2), light brownish gray (2.5Y 6/2), and white (N 8/) extremely gravelly coarse sand; single grain; loose dry and moist; few roots; many very fine pores; 60 percent cinders; neutral; abrupt smooth boundary.

IIAb-60 to 64 inches; dark reddish brown (5YR 3/4) loam; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots; many very fine pores; 10 percent pebbles; neutral; clear smooth boundary.

IIB2b-64 to 94 inches; dark reddish brown (5YR 3/4) loam; weak medium subangular blocky structure; slightly hard, friable to brittle, slightly sticky and slightly plastic; common roots; many very fine pores; neutral.

Bedrock is at a depth of more than 60 inches. The buried soil is at a depth of more than 40 inches. The 10to 40-inch control section has cinders 2 millimeters to 4 centimeters thick. The fine earth fraction is vesicular ash of coarse sand and loamy coarse sand. It has less than 1 to 4 percent clay.

The A1 horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 1 or 2, moist and dry. It is loamy sand and loamy coarse sand. The C horizon has hue of 7.5YR to 5Y; value of 4 to 8, moist and 6 to 8, dry; and chroma of 2 to 8, moist and 0 to 6, dry.

Lather series

The Lather series consists of very deep, very poorly drained soils in drained marshes. These soils formed in deposits of organic material that has thin layers of silt. Slopes are 0 to 1 percent. The mean annual precipitation is about 20 inches, and the mean annual air temperature is about 43 degrees F. The mean annual soil temperature is 43 to 46 degrees F. A water table is at a depth of 0 to 3 feet.

Typical pedon of Lather muck, in an area of irrigated pasture, about 6 miles south of the town of Fort Klamath, 800 feet south and 50 feet east of the northwest corner sec. 18, T. 34 S., R. 7 1/2 E.:

Oe1-0 to 6 inches; black (N 2/) rubbed, very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) broken face hemic material, very dark gray (N 3/) dry; 70 percent fibers, 20 percent rubbed; weak thin platy structure; slightly hard, spongy; many very fine roots; slightly acid; abrupt smooth boundary.

Oe2-6 to 13 inches; dark brown (7.5YR 3/2) rubbed and pressed, (7.5YR 3/4) broken face hemic material, dark brown (7.5YR 4/2 and 7.5YR 3/2) dry; 50 percent fibers, 10 percent rubbed; massive; slightly hard, friable; many very fine roots; slightly acid; abrupt smooth boundary.

Ldi-13 to 15 inches; black (N 2/) broken face and rubbed diatomaceous silt, gray (N 5/) and white (N 8/) dry; 30 percent fibers, 10 percent rubbed; massive; slightly hard, friable; 70 percent patches and lenses of silt; common very fine roots; slightly acid; abrupt smooth boundary.

Oe3-15 to 70 inches; dark brown (7.5YR 3/4) rubbed, (7.5YR 3/2) pressed, (7.5YR 4/4) broken face hemic material, very dark brown (7.5YR 2/2) dry; 80

percent fibers, 35 percent rubbed; massive; slightly hard, spongy; few very fine roots; water table at a depth of 28 inches; slightly acid.

Organic material is mainly from herbaceous plants. The bottom layer is strongly acid to slightly acid. The control section extends to a depth of 52 inches and dominantly is hemic material. Diatomaceous silt layers are 2 to 4 inches thick, and one or more of these layers is at a depth of 12 to 52 inches.

The surface layer has value of 2 or 3, moist and 3 or 4, dry and chroma of 0 to 2, moist and dry. It has 50 to 90 percent fibers and 10 to 30 percent fibers after rubbing. The surface layer is medium acid to neutral. The Oe2 horizon has 35 to 80 percent fibers and 10 to 40 percent fibers after rubbing. The limnic layer has value of 2 to 4, moist and 5 to 8, dry and chroma of 0 or 1, moist and dry. The bottom has 40 to 95 percent fibers and 20 to 50 percent fibers after rubbing. It is strongly acid to slightly acid.

Lobert series

The Lobert series consists of very deep, well drained soils on terraces and fans. These soils formed in alluvial and lacustrine sediment weathered from diatomite, tuff, and ash. Slopes are 0 to 25 percent. The mean annual precipitation is about 17 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F. The soil generally is moist, and it is dry at depths between 8 and 24 inches for about 65 to 90 days during the 4-month period following June 21.

Typical pedon of Lobert loam, 0 to 2 percent slopes, in an area of woodland, about 1 mile east of Agency Lake, 100 feet north and 300 feet east of the southwest corner sec. 17, T. 35 S., R. 7 E.:

A11-0 to 4 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak thin platy structure parting to weak very fine granular; soft, very friable, slightly sticky and nonplastic; many very fine roots; many very fine pores; 5 percent pebbles; slightly acid; clear smooth boundary.

A12-4 to 9 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to weak very fine granular; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; few very fine tubular pores; 5 percent pebbles; neutral; gradual wavy boundary.

B21-9 to 25 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine tubular pores; 5 percent pebbles; 3 percent durinodes 0.5 to 1 inch in diameter; neutral; gradual wavy boundary.

B22-25 to 41 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; 5 percent firm and brittle durinodes 0.5 to 1.5 inches in diameter; neutral; gradual wavy boundary.

C1si-41 to 50 inches; dark brown (10YR 3/3) fine sandy loam, pale brown (10YR 6/3) dry; massive; soft, very friable, slightly sticky and nonplastic; few very fine roots; common very fine pores; 35 percent firm and brittle durinodes 1 inch to 3 inches in diameter; neutral; clear wavy boundary.

C2si-50 to 60 inches; dark brown (10YR 3/3) loamy fine sand, brown (10YR 5/3) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine pores; 15 percent firm and brittle durinodes; neutral.

Bedrock is at a depth of more than 60 inches. The 10- to 40-inch control section has 0 to 15 percent hard lava rock fragments. The mollic epipedon is 20 to more than 40 inches thick. The solum is slightly acid and neutral.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 2, moist and dry. The B2 horizon has value of 3 or 4, moist and 5 or 6, dry and chroma of 2 or 3, moist and dry. It is loam or fine sandy loam and sandy loam and has 10 to 18 percent clay. Durinodes range from 0 to 20 percent by volume, and they are brittle but can be crushed by hand pressure when moist. The C horizon has value of 3 or 4, moist and 5 or 6, dry and chroma of 2 to 4, moist and dry.

Lorella series

The Lorella series consists of shallow, well drained soils on escarpments and rock benches. These soils formed in residual material weathered from tuff and basalt. Slopes are 1 to 35 percent. The mean annual precipitation is about 14 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 53 degrees F. The soil generally is dry, and it is dry at depths between 4 and 12 inches for 100 to 120 days during the 4-month period following June 21.

Typical pedon of Lorella very stony loam, 2 to 35 percent south slopes, in an area of rangeland, on the southern side of Bly Mountain, 2,730 feet east and 1,200 feet north of the southwest corner sec. 27, T. 37 S., R. 11 E.:

A1-0 to 2 inches; very dark grayish brown (10YR 3/2) very stony loam, grayish brown (10YR 5/2) dry; weak thin platy structure parting to weak very fine granular; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many fine vesicular pores to a depth of 1 inch and many very fine pores to a depth of 2 inches; 60 percent pebbles, cobbles, and stones; neutral; abrupt smooth boundary.

A3-2 to 5 inches; very dark grayish brown (10YR 3/2) very gravelly loam, grayish brown (10YR 5/2) dry; weak medium platy structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; 50 percent pebbles, cobbles, and stones; neutral; clear smooth boundary.

B1-5 to 10 inches; dark brown (10YR 3/3) very cobbly clay loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; 50 percent pebbles, cobbles, and stones; neutral; clear smooth boundary.

B2t-10 to 19 inches; dark yellowish brown (10YR 4/4) very cobbly clay, pale brown (10YR 6/3) dry; moderate medium and fine angular blocky structure; very hard, very firm, very sticky and very plastic; few very fine roots; many very fine tubular pores; many stress cutans on faces of peds; 55 percent pebbles, cobbles, and stones, some with opal coatings on undersides; neutral; abrupt smooth boundary.

R-19 inches; dark brown (10YR 4/3) fractured volcanic tuff; moderately thick clay films on fracture surfaces.

Solum thickness and depth to bedrock are 10 to 20 inches. The solum is neutral and slightly acid.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 2 or 4, moist and dry. It has 5 to 35 percent pebbles and 0 to 45 percent cobbles and stones. The B2t horizon has hue of 10YR and 7.5YR; value of 2 to 4, moist and 4 to 6, dry; and chroma of 2 to 4, moist and dry. It is heavy clay loam and clay and has 35 to 50 percent clay. This horizon has 5 to 50 percent pebbles, 10 to 35 percent cobbles and stones, and 40 to 60 percent total rock fragments.

Maklak series

The Maklak series consists of very deep, excessively drained soils on pumice flows. These soils formed in cinders and ash. Slopes are 1 to 12 percent. The mean annual precipitation is about 35 inches, and the mean annual air temperature is about 43 degrees F. The mean annual soil temperature is 42 to 45 degrees F, and the mean summer soil temperature without an O horizon is 53 to 58 degrees F.

Typical pedon of Maklak gravelly loamy coarse sand, 1 to 12 percent slopes, in an area of mixed conifer woodland, about 1 /4 mile south of the southern boundary of Crater Lake National Park, NE1/4NW1/4 sec. 19, T. 32 S., R. 7 1/2 E.:

A1-0 to 3 inches; very dark brown (10YR 2/2) gravelly loamy coarse sand, dark gray (10YR 4/1) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine pores; 20 percent cinders 2 to 76 millimeters thick; strongly acid; abrupt smooth boundary.

AC1-3 to 10 inches; dark brown (7.5YR 3/4) very gravelly loamy coarse sand, light brown (7.5YR 6/3) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine pores; 35 percent cinders 2 to 76 millimeters thick and 15 percent cinders more than 76 millimeters thick; medium acid; clear wavy boundary.

AC2-10 to 27 inches; dark brown (7.5YR 4/4) very gravelly loamy coarse sand; massive; soft, very friable, nonsticky and nonplastic; common roots; many very fine pores; 45 percent cinders 2 to 76 millimeters thick and 15 percent cinders more than 76 millimeters thick; slightly acid; gradual wavy boundary.

C1-27 to 37 inches; dark reddish brown (5YR 3/4) extremely gravelly loamy coarse sand; massive; soft, very friable, nonsticky and nonplastic; common roots; many very fine pores; 55 percent cinders 2 to 76 millimeters thick and 15 percent cinders more than 76 millimeters thick; medium acid; gradual wavy boundary.

C2-37 to 60 inches; dark reddish brown (5YR 3/2) very gravelly coarse sand; massive; soft, very friable, nonsticky and nonplastic; few roots; many very fine pores; 45 percent cinders 2 to 76 millimeters thick and 15 percent cinders more than 76 millimeters thick; medium acid.

Bedrock is at a depth of more than 60 inches. The soil is cindery and consists of pumiceous and scoriaceous pebbles, cobbles, and ash. The fines include much lithic crystal ash. The 10- to 40-inch control section has 35 to 80 percent cinders of which 15 to 25 percent is more than 3 inches in diameter.

The A1 horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 2, moist and 1 or 2, dry. The C horizon has hue of 7.5YR, 5YR, and 10YR; value of 3 to 7, moist and 6 to 8, dry; and

Malin series

The Malin series consists of very deep, somewhat poorly drained soils on flood plains and drained lake bottoms. These soils formed in alluvial and lacustrine sediment that includes a small amount of ash. Slopes are 0 to 1 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. Mean annual soil temperature is from 48 to 50 degrees F. A water table is at a depth of 1.5 to 5 feet.

Typical pedon of Malin clay loam, in an area of irrigated pasture, in the south end of Poe Valley, 2,100 feet east and 1,600 feet south of the northwest corner sec. 5, T. 39 S., R. 11 1 /2 E.:

Ap-0 to 6 inches; black (10YR 2/1) clay loam, dark gray (N 4/) dry; moderate medium angular blocky structure; very hard, friable, sticky and plastic; many very fine roots; many very fine pores; weakly effervescent; strongly alkaline; abrupt smooth boundary.

A12-6 to 14 inches; black (N 2/) silty clay, gray (N 5/) dry, common fine grayish brown mottles; moderate medium angular blocky structure; very hard, very firm, very sticky and very plastic; common very fine roots; common very fine tubular pores; continuous stress cutans on ped surfaces; strongly effervescent; very strongly alkaline; clear smooth boundary.

AC-14 to 21 inches; black (10YR 2/1) heavy clay loam, gray (N 6/) dry, many medium dark grayish brown (10YR 4/2) mottles; moderate fine angular blocky structure; very hard, firm, sticky and plastic; common very fine roots; common fine and very fine tubular pores; strongly effervescent; strongly alkaline; clear smooth boundary.

C1-21 to 43 inches; very dark grayish brown (2.5Y 3/2) clay loam, gray (N 6/) dry, common medium dark grayish brown (2.5Y 4/2) mottles; massive; hard, firm, sticky and plastic; few very fine roots; many fine and very fine tubular pores; strongly effervescent; strongly alkaline; clear smooth boundary.

C2-43 to 64 inches; very dark grayish brown (2.5Y 3/2) clay loam, light gray (10YR 7/1) dry, common medium dark grayish brown (2.5Y 4/2) mottles; massive; very hard, firm, sticky and plastic; few very fine roots; many very fine pores; strongly effervescent; moderately alkaline.

Exchangeable sodium exceeds 15 percent in the mollic epipedon and decreases at a depth below 20 inches. The soil is calcareous at depths of 10 to 20 inches. The mollic epipedon ranges from 10 to 24 inches thick. The 10- to 40-inch control section is 35 to 50 percent clay and more than 15 percent particles coarser than very fine sand.

The A horizon has value of 2 or 3 moist and 4 or 5 dry, and

Malin Variant

The Malin Variant consists of very deep, somewhat poorly drained soils on small lakebeds. These soils formed in lacustrine sediment. Slopes are 0 to 1 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 50 degrees F. A water table is at a depth of 0 to 3.5 feet.

Typical pedon of Malin Variant silt loam, in an area of nearly barren pasture, about 1 mile northeast of the town of Midland, 1,600 feet west and 800 feet south of the northeast corner sec. 31, T. 39 S., R. 9 E.:

A11-0 to 3 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/1) dry; weak very thin platy structure; hard, friable, slightly sticky and slightly plastic; no roots; many fine vesicular pores; strongly effervescent; very strongly alkaline; abrupt smooth boundary.

A12-3 to 6 inches; dark grayish brown (10YR 4/2) silt loam, gray (10YR 6/1) dry; moderate thin platy structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; strongly effervescent; very strongly alkaline; abrupt smooth boundary.

B21t-6 to 10 inches; very dark grayish brown (2.5Y 3/ 2) silty clay loam, gray (2.5Y 6/1) dry, dark grayish brown (2.5Y 4/2) crushed; moderate very fine angular blocky structure; very hard, firm, very sticky and very plastic; few very fine roots; common very fine tubular pores; nearly continuous stress cutans on ped faces; strongly effervescent; very strongly alkaline; clear wavy boundary.

B22tca-10 to 16 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry, olive brown (2.5Y 4/4) crushed; many fine light olive brown lime segregations; moderate very fine angular blocky structure; very hard, firm, very sticky and very plastic; few very fine roots; many very fine tubular pores; nearly continuous stress cutans on ped faces; strongly effervescent; very strongly alkaline; clear wavy boundary.

Cca-16 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay loam, light brownish gray (2.5Y 6/2) and light gray (2.5Y 7/2) dry; many light brownish gray (2.5Y 6/2) lime segregations; weak fine angular blocky structure; very hard, friable, sticky and plastic; few very fine roots; many very fine tubular pores; strongly effervescent in lime segregations; strongly alkaline.

Exchangeable sodium exceeds 15 percent, and the soil is calcareous in all parts. The solum is 10 to 24 inches thick.

The A horizon has value of 3 or 4, moist and 6 or 7, dry and chroma of 1 or 2, moist and dry. The B2t horizon has value of 3 or 4, moist and 5 or 6, dry and chroma of 2 to 4, moist and 1 or 2, dry. It is silty clay loam and silty clay. The Bt horizon has 35 to 50 percent clay and less than 15 percent particles that are coarser than very fine sand. This horizon commonly is mottled by lime in the lower part or throughout. The C horizon has value of 3 or

4, moist and 6 to 8, dry and chroma of 1 or 2, moist and dry. It is silty clay loam and clay loam.

Maset series

The Maset series consists of moderately deep, well drained soils on benches, escarpments, and hills. These soils formed in a thin mantle of ash on a buried loamy soil. Slopes are 1 to 45 percent. The mean annual precipitation is about 18 inches, and the mean annual air temperature is about 43 degrees F. The mean annual soil temperature is 42 to 45 degrees F, and the mean summer soil temperature is 52 to 59 degrees F.

Typical pedon of Maset coarse sandy loam, 12 to 35 percent south slopes, in an area of woodland, about 7 miles northeast of the town of Beatty, 3,700 feet east and 1,600 feet south of the northwest corner sec. 20, T. 35 S., R. 13 E.:

A11-0 to 4 inches; very dark grayish brown (10YR 3/2) coarse sandy loam, light brownish gray (10YR 6/2) dry; weak very fine granular structure; soft, very friable, slightly sticky and nonplastic; many very fine roots; many very fine pores; 10 percent pebbles of hard lava; slightly acid; clear wavy boundary.

A12-4 to 8 inches; very dark grayish brown (10YR 3/2) coarse sandy loam, light brownish gray (10YR 6/2) dry; massive; soft, very friable, slightly sticky and nonplastic; common fine and very fine roots; many very fine pores; 10 percent pebbles of hard lava; slightly acid; clear wavy boundary.

AC-8 to 17 inches; dark brown (10YR 3/3) gravelly coarse sandy loam, pale brown (10YR 6/3) dry; massive; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; many very fine pores; 15 percent pebbles and 5 percent cobbles of hard lava; slightly acid; gradual wavy boundary.

C-17 to 21 inches; dark brown (10YR 3/3) gravelly coarse sandy loam, pale brown (10YR 6/3) dry; massive; soft, very friable, slightly sticky and nonplastic; common fine and very fine roots; many very fine pores; 15 percent pebbles and 5 percent cobbles of hard lava; slightly acid; clear wavy boundary.

IIA1b-21 to 24 inches; dark brown (10YR 3/3) gravelly sandy loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; common very fine tubular pores; 20 percent pebbles, 5 percent cobbles, and 5 percent stones; slightly acid; abrupt smooth boundary.

IIB2tb-24 to 32 inches; dark brown (10YR 3/3) very gravelly clay loam, yellowish brown (10YR 5/4) dry, dark brown (10YR 4/3) crushed; moderate fine subangular blocky structure; hard, firm, sticky and plastic; common fine and very fine roots; many very fine tubular pores; 35 percent pebbles and 5 percent cobbles; common thin clay films on peds and few clay films in pores; slightly acid; clear wavy boundary.

IICr-32 to 34 inches; dark yellowish brown (10YR 3/4) weathered tuffaceous sandstone, light yellowish brown (10YR 6/4) dry; laminated.

The upper part of the soil formed in pumiceous dacitic ash that has less than 40 percent other mineral constituents. It has 0 to 5 percent fine cinders and 5 to 20 percent hard rock fragments. The buried soil has mixed mineralogy and has 35 to 65 percent hard rock fragments. The ashy upper part commonly is 20 to 30 inches thick and ranges from 14 to 35 inches. Soft bedrock is at a depth of 20 to 40 inches.

The A horizon has value of 2 or 3, moist and 6 or 7, dry and chroma of 2 or 3, moist and dry. The 1182b horizon has hue of 10YR and 7.5YR; value of 3 or 4, moist and 5 to 7, dry; and chroma of 2 to 4, moist and dry. It is very gravelly and is loam or clay loam and has 18 to 35 percent clay. Some pedons do not

Merlin series

The Merlin series consists of shallow, well drained soils on tablelands. These soils formed in residual material weathered from tuff and basalt. Slopes are 1 to 8 percent. The mean annual precipitation is about 15 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 46 degrees F. The soil generally is moist, but it is dry at depths between 4 and 12 inches for 75 to 90 days during the 4-month period following June 21.

Typical pedon of Merlin extremely stony clay loam, 1 to 8 percent slopes, in an area of rangeland, about 3 miles east of the town of Bly, 80 feet west and, 1,650 feet north of the southeast corner sec. 31, T. 36 S., R. 15 E.:

A1-0 to 4 inches; very dark brown (7.5YR 2/2) extremely stony clay loam, dark brown (7.5YR 4/2) dry; weak thin platy structure parting to weak fine granular; hard, firm, sticky and slightly plastic; common very fine roots; common very fine tubular pores; neutral; clear wavy boundary.

B1t-4 to 12 inches; dark brown (7.5YR 3/2) clay loam, dark brown (7.5YR 4/3) dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; common very fine tubular pores; thick continuous cutans on surfaces of peds and thin clay films in pores; neutral; clear wavy boundary.

B2t-12 to 18 inches; dark brown (7.5YR 3/4) clay, dark brown (7.5YR 4/3) dry; common very dark grayish brown coatings in interiors of peds and on faces of some peds; moderate coarse subangular blocky structure; extremely hard, extremely firm, very sticky and very plastic; common very fine roots; common very fine tubular pores; thick continuous stress cutans on surfaces of peds and thin clay films in pores; neutral; abrupt irregular boundary.

R-18 inches; lava.

Hard basaltic or tuffaceous bedrock is at a depth of 10 to 20 inches. The solum has hue of 7.5YR or 10YR.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 2, moist and 1 or 2, dry. It is extremely stony and is loam or clay loam and has 10 to 30 percent stones and cobbles and 10 to 30 percent pebbles. The Bt horizon has value of 4 or 5, dry and chroma of 2 to 4, moist and dry. It has 35 to 60 percent clay. The B2t horizon has 0 to 15 percent pebbles and 0 to 5 percent cobbles and stones.

Modoc series

The Modoc series consists of moderately deep, well drained soils on terraces. These soils formed in lacustrine sediment weathered from tuff, diatomite, basalt, and a small amount of ash. Slopes are 0 to 15 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 53 degrees F. The soil generally is dry, and it is dry at depths between 4 and 12 inches for 80 to 120 consecutive days during the 4-month period following June 21.

Typical pedon of Modoc fine sandy loam, 2 to 5 percent slopes, in an area of irrigated cropland, about 5 miles south of Klamath Falls, 1,800 feet west and 700 feet south of the northeast corner sec. 2, T. 40 S., R. 9 R.:

Ap-0 to 8 inches; very dark brown (10YR 2/2) fine sandy loam, gray (10YR 5/1) dry, very dark grayish brown (10YR 3/2) crushed; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; neutral; abrupt smooth boundary.

A12-8 to 12 inches; very dark brown (10YR 2/2) fine sandy loam, gray (10YR 5/1) dry, very dark grayish brown (10YR 3/2) crushed; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; neutral; clear smooth boundary.

B1-12 to 16 inches; dark brown (10YR 3/3) sandy clay loam, grayish brown (10YR 5/2) dry; very dark grayish brown (10YR 3/2) coatings on ped surfaces; moderate fine subangular blocky structure; slightly hard, friable, sticky and plastic; common very fine roots; many very fine pores; neutral; clear smooth boundary.

B21t-16 to 23 inches; dark brown (10YR 3/3) sandy clay loam, grayish brown (10YR 5/2) dry, dark yellowish brown (10YR 4/4) crushed; moderate fine and medium angular blocky structure; hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; common thin cutans on peds and thin clay films in pores; neutral; gradual smooth boundary.

B22t-23 to 32 inches; dark yellowish brown (10YR 3/4) clay loam, brown (10YR 5/3) dry, dark yellowish brown (10YR 4/4) crushed; moderate fine and medium angular blocky structure; hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores,,-many cutans on peds and thin clay films in pores; neutral; abrupt smooth boundary.

Csim-32 to 60 inches; yellowish brown (10YR 5/4) duripan, light gray (10YR 7/1) dry; platy structure; indurated to a depth of 38 inches, strongly cemented to a depth of 51 inches, and weakly cemented to a depth of 60 inches; light gray (10YR 7/1) indurated opaline laminar caps at depths of 32 inches, 38 inches, and 51 inches; light gray (10YR 7/1) silica coatings along vertical fractures; strongly effervescent; mildly alkaline.

The duripan is at a depth of 20 to 40 inches. Mineralogy of the solum is mixed. The mollic epipedon is 7 to 20 inches thick. The solum is slightly acid or neutral. The duripan ranges from 12 inches to more than 48 inches in thickness.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 2, moist and 1 or 2, dry. The B2t horizon has value of 3 or 4, moist and 5 or 6, dry and chroma of 2 to 4, moist and 2 or 3, dry. The Bt horizon has 25 to 35 percent clay, 35 to 55 percent particles that are coarser than very fine sand, and 0 to 15 percent pebbles.

Nuss series

The Nuss series consists of shallow, well drained soils on escarpments, hills, and benches. These soils formed in material weathered from lava rocks that include a small amount of ash. Slopes are 1 to 40 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 46 degrees F. The soil generally is moist, but it is dry at depths between 4 and 12 inches for 80 to 90 days during the 4-month period following June 21.

Typical pedon of Nuss loam, 1 to 8 percent slopes, in an area of woodland, about 10 miles north of the town of Bonanza, 800 feet north and 300 feet west of the southeast corner sec. 26, T. 37 S., R. 11 E.:

A1-0 to 3 inches; dark brown (7.5YR 3/2) loam, brown (7.5YR 5/3) dry; moderate very thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; common very fine tubular pores; 5 percent pebbles; slightly acid; abrupt smooth boundary.

A3-3 to 8 inches; dark brown (7.5YR 3/3) loam, brown (7.5YR 5/3) dry; moderate medium and fine subangular blocky structure; slightly hard, friable, sticky and slightly plastic; common fine and very fine roots; common very fine tubular pores; 10 percent pebbles; neutral; clear smooth boundary.

B2-8 to 13 inches; dark brown (7.5YR 3/4) clay loam, brown (7.5YR 5/3) dry; moderate medium and fine subangular blocky structure; hard, friable, sticky and plastic; common fine and very fine roots; common very fine tubular pores; 15 percent pebbles; slightly acid; abrupt wavy boundary.

Cr-13 to 15 inches; dark brown (7.5YR 4/3) tuff, pinkish gray (7.5YR 6/2) dry; partially weathered.

Soft bedrock is at a depth of 12 to 20 inches. The mollic epipedon is 7 to 16 inches thick. The solum is slightly acid or neutral. It has hue of 10YR or 7.5YR.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 1 to 3, moist and dry. It has 5 to 20 percent pebbles. The B2 horizon has value of 2 to 4, moist and 4 to 6, dry and chroma of 2 to 4, moist and dry. It is loam or clay loam and has 18 to 30 percent clay and as much as 20 percent soft tuffaceous pebbles.

Oatman series

The Oatman series consists of very deep, well drained soils on volcanic cones. These soils formed in colluvium weathered from andesite, scoriaceous cinders, and basalt. Slopes are 5 to 45 percent. The mean annual precipitation is about 40 inches, and the mean annual air temperature is about 42 degrees F. The mean annual soil temperature is 41 to 45 degrees F, and the mean summer soil temperature without an O horizon is 50 to 58 degrees F.

Typical pedon of Oatman very gravelly loam, 5 to 45 percent slopes, in an area of conifer forest, on the northeast slope of Pelican Butte along U. S. Forest Service Road No. 3562, 1,620 feet north and 500 feet east of the southwest corner sec. 11, T. 35 S., R. 6 E.:

O1-3 inches to 0; needle mat, needles partially decomposed in lower part.

A11-0 to 2 inches; dark brown (7.5YR 3/3) very gravelly loam, brown (7.5YR 5/3) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine pores; 45 percent pebbles and 10 percent cobbles and stones; slightly acid; clear wavy boundary.

A12-2 to 6 inches; dark brown (7.5YR 3/4) very gravelly loam, brown (7.5YR 5/4) dry; weak very fine granular structure; soft, very friable, nonsticky and slightly plastic; many roots; many very fine pores; 40 percent pebbles and 10 percent cobbles and stones; slightly acid; clear wavy boundary.

A3-6 to 17 inches; dark brown (7.5YR 3/4) very gravelly loam, light brown (7.5YR 6/3) dry; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; many roots; many very fine pores; 40 percent pebbles and 10 percent cobbles and stones; slightly acid; gradual wavy boundary.

B21-17 to 26 inches; dark yellowish brown (10YR 3/4) very gravelly loam, light yellowish brown (10YR 6/4) dry; weak very fine and fine granular structure; soft, very friable, slightly sticky and slightly plastic; common roots; many very fine pores; 40 percent pebbles and 10 percent cobbles and stones; slightly acid; gradual wavy boundary.

B22-26 to 34 inches; dark yellowish brown (10YR 3/4) very gravelly loam, pale brown (10YR 6/3) dry; weak very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few roots; few very fine tubular pores; 40 percent pebbles and 20 percent cobbles and stones; slightly acid; gradual wavy boundary.

C-34 to 60 inches; dark brown (10YR 3/3) very gravelly loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few roots; many very fine pores; 40 percent pebbles and 25 percent cobbles and stones; neutral.

Bedrock is at a depth of more than 60 inches. The A horizon has 20 to 65 percent rock fragments that include 0 to 15 percent cobbles and stones. The 10- to 40-inch control section has 35 to 80 percent rock fragments that include 0 to 25 percent cobbles and stones. It also has 18 to 27 percent clay. The solum is slightly acid to medium acid.

The A horizon has value of 3 or 4, moist and 4 or 5, dry and chroma of 2 to 4, moist and 3 or 4, dry. The B horizon has hue of 10YR or 7.5YR; value of 3 or 4, moist and 5 or 6, dry; and chroma of 4, moist and 3 or 4, dry. The C horizon has hue of 10YR or 7.5YR; value of 3 or 4, moist and 5 or 6, dry; and chroma of 3 or 4, moist and 3 to 5, dry.

Ontko series

The Ontko series consists of very deep, poorly drained soils on flood plains. These soils formed in alluvium that contains layers of ash. Slopes are 0 to 1 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F, and the mean summer soil temperature is 56 to 59 degrees F. A water table is at a depth of 0 to 4 feet.

Typical pedon of Ontko silty clay loam, in an area of irrigated meadow, on Wolf Flat, about 9 miles east of the village of Chiloquin, 1,400 feet east and 75 feet north of the southwest corner sec. 31, T. 34 S., R. 9 E.:

A11-0 to 2 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate thin platy structure; hard, firm; sticky and plastic; many very fine roots; many very fine pores; many coarse pumice sand grains; neutral; abrupt smooth boundary.

A12-2 to 7 inches; black (10YR 2/1) silty clay loam, gray (10YR 5/1) dry; weak coarse prismatic structure parting to moderate medium angular blocky; very hard, very firm, very sticky and very plastic; common very fine roots; many very fine pores; many weathered coarse pumice sand grains; neutral; gradual wavy boundary.

B2-7 to 13 inches; dark gray (10YR 4/1) clay loam, gray (10YR 6/1) dry; weak coarse prismatic structure parting to moderate fine angular blocky; hard, friable, very sticky and plastic; few very fine roots; many very fine pores; 40 percent weathered coarse pumice sand grains; neutral; gradual smooth boundary.

IIC1-13 to 22 inches; dark grayish brown (10YR 4/2) coarse sandy loam, light brownish gray (10YR 6/2) dry; massive; soft, very friable, slightly sticky and nonplastic; few very fine roots; many very fine pores; dominantly unweathered pumice ash; neutral; diffuse smooth boundary.

IIC2-22 to 28 inches; very dark grayish brown (10YR 3/2) loamy coarse sand, gray (10YR 6/1) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; many very fine pores; essentially unweathered pumice ash; neutral; abrupt smooth boundary.

IIIC3-28 to 60 inches; dark grayish brown (10YR 4/2) clay loam, light gray (10YR 7/2) dry; massive; hard, firm, sticky and plastic; no roots; many very fine pores; neutral.

The soil has more than 60 percent pyroclastic and equivalent material in the upper part including pumiceous ash and material weathered from ash and diatomite. The ashy upper part of the control section has 10 to 35 percent cinders 2 to 5 millimeters thick. Depth to the loamy IIIC horizon is 20 to 40 inches. The solum is neutral. The mollic epipedon is 7 to 13 inches thick.

The A horizon has value of 2 or 3, moist and chroma of 0 or 1, moist and dry. The B2 horizon has value of 2 to 4, moist and 4 to 6, dry and chroma of 0 to 2, moist. It is clay loam, silty clay loam, and clay. The IIC horizon has value of 3 to 5, moist and 6 to 8, dry and chroma of 0 to 3, moist and dry. The IIIC horizon has value of 3 or 4,

Pit series

The Pit series consists of very deep, poorly drained soils on drained lake bottoms and flood plains. These soils formed in clayey sediment weathered from tuff and basalt. Slopes are 0 to 1 percent. The mean annual precipitation is about 13 inches, and the mean annual air temperature is about 47 degrees F. The mean annual soil temperature is 48 to 50 degrees F. A water table is at a depth of 0 to 4 feet.

This is taxadjunct to the Pit series because the chroma is less than 1.5 to a depth of 40 inches or more.

Typical pedon of Pit silty clay, in an area of irrigated cropland, about 3 miles southeast of the town of Lorella, 1,700 feet east and 50 feet south of the northwest corner sec. 24, T. 40 S., R. 13 E.:

Ap-0 to 6 inches; black (N 2/) silty clay, very dark gray (N 3/) dry; moderate medium and fine angular blocky structure parting to strong very fine granular; very hard, very firm, very sticky and very plastic; few very fine roots; many very fine pores; neutral; abrupt smooth boundary.

A12-6 to 12 inches; black (N 2/) clay, very dark gray (N 3/) dry; moderate medium angular blocky structure; very hard, very firm, very sticky and very plastic; few very fine roots; many very fine pores; mildly alkaline; clear smooth boundary.

A13-12 to 20 inches; black (N 2/) clay, very dark gray (N 3/) dry; weak coarse prismatic structure; very hard, very firm, very sticky and very plastic; few very fine roots; many very fine pores; few wedge shaped aggregates; many cutans on prisms; moderately alkaline; clear smooth boundary.

A14-20 to 33 inches; black (N 2/) clay, very dark gray (N 3/) dry; weak coarse prismatic structure; very hard, very firm, very sticky and very plastic; few very fine roots; many very fine pores; many wedge shaped structural aggregates; many intersecting slickensides; weakly effervescent; moderately alkaline; clear wavy boundary.

C1ca-33 to 42 inches; very dark gray (N 3/) silty clay, dark gray (N 4/) dry; strong medium and fine angular blocky structure; very hard, very firm, very sticky and very plastic; few very fine roots; many very fine pores; many medium distinct white (N 8/) lime segregations; many cutans on peds; strongly effervescent in lime segregations; moderately alkaline; clear wavy boundary.

C2-42 to 60 inches; very dark gray (2.5Y 3/1) silty clay, gray (2.5Y 6/1) dry; strong medium and very fine angular blocky structure; very hard, very firm, very sticky and very plastic; few very fine roots; many very fine tubular pores; many cutans on peds; weakly effervescent; moderately alkaline.

Bedrock is at a depth of more than 60 inches. Solum thickness ranges from 25 to 35 inches. Slickensides that are numerous enough to intersect are at a depth of 8 to 24 inches. Carbonates are at a depth of 20 to 40 inches.

The A horizon has value of 2, moist and 3 to 5, dry and chroma of 0 or 1, moist and dry. It is silty clay and clay. The C horizon has hue of 10YR, 2.5Y, and neutral;

value of 3 to 5, moist and 4 to 6, dry; and chroma of 0 to 3, moist and dry. It has distinct and prominent mottles with chroma of 1 or more. This horizon is silty clay and silty clay loam.

Poe series

The Poe series consists of moderately deep, somewhat poorly drained soils on terraces. These soils formed in alluvial and lacustrine sediment weathered from tuff, basalt, diatomite, and ash. Slopes are 0 to 2 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 51 degrees F. A water table is at a depth of 2 to 4 feet.

Typical pedon of Poe loamy fine sand, in an area of irrigated pasture, about 4 miles east and 3 miles south of Klamath Falls, 2,700 feet east and 1,350 feet south of the northwest corner of sec. 29, T. 39 S., R. 10 E.:

Ap1-0 to 3 inches; very dark brown (10YR 2/2) loamy fine sand, gray (10YR 5/1) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine pores; strongly effervescent; moderately alkaline; clear smooth boundary.

Ap2-3 to 9 inches; very dark brown (10YR 2/2) loamy sand, gray (10YR 5/1) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; few medium and common very fine tubular pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

AC-9 to 16 inches; very dark grayish brown (10YR 3/2) loamy sand, gray (10YR 5/1) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; few very fine tubular pores; strongly effervescent; moderately alkaline; gradual smooth boundary.

C1-16 to 22 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; weakly effervescent; moderately alkaline; gradual smooth boundary.

C2-22 to 30 inches; dark grayish brown (10YR 4/2) loamy sand, light brownish gray (10YR 6/2) dry; few fine faint dark brown mottles; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine tubular pores; mildly alkaline; abrupt wavy boundary.

IIC3sim-30 to 36 inches; very dark grayish brown (10YR 3/2) and very dark brown (10YR 2/2) indurated duripan; platy structure; extremely firm; few very fine roots in vertical fractures; vertical fractures coated with dark brown (10YR 4/3) opal; gray (10YR 6/1) indurated laminar cap at top of duripan; moderately alkaline; abrupt smooth boundary.

IIC4sim-36 to 46 inches; very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) indurated duripan; platy structure; extremely firm; few very fine roots in vertical fractures; vertical fractures coated with opal; gray (10YR 6/1) indurated laminar cap at top of duripan; moderately alkaline.

The epipedon is less than 1 percent organic matter, and it has many dark uncoated mineral grains. The soil is moderately alkaline to very strongly alkaline above the duripan. The soil above the duripan has 0 to 5 percent pebbles 2 to 5 millimeters thick. The duripan is at a depth of 20 to 40 inches. The soil has hue of 10YR and 2.5Y. The duripan is 4 to more than 30 inches thick and has an indurated opal cap 1 millimeter to 2 millimeters thick and vertical coatings of opal.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 1 or 2, dry. The C horizon has value of 3 or 4, moist and 5 or 6, dry. It has as much as 15 percent durinodes.

Poe Variant

The Poe Variant consists of shallow, somewhat poorly drained soils on terraces. These soils formed in alluvial and lacustrine sediment weathered from tuff, basalt, diatomite, and ash. Slopes are 0 to 2 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 50 degrees F. A water table is at a depth of below 1.5 feet.

Typical pedon of Poe Variant loamy fine sand, in an area of irrigated grain, about 1 mile west of the town of Malin, 2,600 feet south and 100 feet east of the northwest corner sec. 16, T. 41 S., R. 12 E.:

Ap-0 to 4 inches; very dark grayish brown (2.5Y 3/2) loamy fine sand, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine pores; weakly effervescent; strongly alkaline; clear smooth boundary.

C1-4 to 14 inches; very dark grayish brown (2.5Y 3/2) loamy fine sand; grayish brown (2.5Y 5/2) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine pores; weakly effervescent; strongly alkaline; abrupt smooth boundary.

C2sim-14 to 60 inches; dark grayish brown (2.5Y 4/2) duripan, gray (2.5Y 6/1) dry; platy structure to a depth of 4 inches, massive to a depth of 60 inches; indurated and extremely firm to a depth of 18 inches, strongly cemented and very firm to a depth of 60 inches; light brownish gray (2.5Y 6/2) laminar opaline cap about 1 millimeter thick at top of pan; strongly effervescent; strongly alkaline.

The epipedon has less than 1 percent organic matter and many dark mineral grains. The soil is moderately alkaline to very strongly alkaline above the duripan. The soil above the duripan has 0 to 5 percent pebbles 2 to 5 millimeters thick. The duripan is at a depth of 10 to 20 inches. The duripan is about 10 to more than 50 inches thick and has an indurated opal cap 1 millimeter to 2 millimeters thick and vertical coatings of opal. The soil has hue of 10YR and 2.5Y.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 1 or 2, dry. The C horizon has value of 3 or 4, moist and 5 or 6, dry. It is loamy fine sand and loamy sand.

Ponina series

The Ponina series consists of well drained, shallow soils on tablelands. These soils formed in residual material weathered from flow breccia, tuff, and basalt. Slopes are 1 to 8 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 46 degrees F. The soil generally is moist, but it is dry at depths between 4 and 12 inches for 80 to 90 days in the 4-month period following June 21.

Typical pedon of Ponina extremely stony clay loam, 1 to 8 percent slopes, in an area of rangeland, about 0.5 mile north of Ferguson Mountain, 2,400 feet south and 2,400 feet east of the northwest corner sec. 33, T. 35 S., R. 13 E.:

A1-0 to 3 inches; dark brown (10YR 3/3) extremely stony clay loam, light brownish gray (10YR 6/2) dry; weak thin platy structure; hard, firm, sticky and plastic; common very fine roots; many very fine vesicular pores; 30 percent cover of basaltic stones and cobbles; slightly acid; abrupt smooth boundary.

B21t-3 to 15 inches; dark yellowish brown (10YR 3/4) clay, dark yellowish brown (10YR 4/4) dry; moderate fine angular blocky structure; very hard, very firm, very sticky and very plastic; many very fine roots; common very fine tubular pores; continuous stress cutans on surfaces of peds; neutral; clear smooth boundary.

B22t-15 to 18 inches; dark brown (7.5YR 4/4) clay, yellowish brown (10YR 5/4) dry, strong brown (7.5YR 5/6) crushed; moderate fine angular blocky structure; very hard, very firm, very sticky and very plastic; many very fine roots; many very fine tubular pores; 10 percent pebbles; continuous stress cutans on surfaces of peds; neutral; abrupt wavy boundary.

Csim-18 to 60 inches; dark brown (7.5YR 4/4) duripan, very pale brown (10YR 7/4) dry; platy structure; indurated, extremely firm; continuous brown (7.5YR 5/4) laminar cap about 2 to 5 millimeters thick at top of pan.

The duripan is at a depth of 12 to 20 inches. It is indurated and platy. Bedrock is at a depth of more than 60 inches. The argillic horizon has 5 to 15 percent pebbles and 0 to 5 percent cobbles of hard lava. The solum has hue of 10YR and 7.5YR.

The A horizon has value of 3 or 4, moist and 6 or 7, dry and chroma of 2 or 3, moist and 2, dry. It has 5 to 20 percent pebbles and 15 to 30 percent cobbles and stones. The B2t horizon has value of 3 to 5, moist and 4 to 6, dry and chroma of 3 to 6, moist and 3 or 4, dry. It has 50 to 60 percent clay.

Royst series

The Royst series consists of moderately deep, well drained soils on escarpments and rock benches. These soils formed in material weathered from lava rocks that include a small amount of ash. Slopes are 1 to 40 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 46 degrees F. The soil generally is moist, but it is dry at depths between 4 and 12 inches for 80 to 90 days during the 4-month period following June 21.

Typical pedon of Royst stony loam, 1 to 8 percent slopes, in an area of woodland, about 9 miles north of the town of Bonanza, 700 feet south and 500 feet west of the northeast corner sec. 35, T. 37 S., R. 11 E.:

A1-0 to 3 inches; very dark grayish brown (10YR 3/2) stony loam, grayish brown (10YR 5/2) dry; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; 30 percent fine pebbles; few scattered stones on surface; slightly acid; clear smooth boundary.

A3-3 to 10 inches; very dark grayish brown (10YR 3/2) very gravelly loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak very fine granular; slightly hard, friable, sticky and slightly plastic; many very fine roots; common very fine tubular pores; 40 percent fine pebbles; slightly acid; clear smooth boundary.

B1-10 to 15 inches; dark brown (7.5YR 3/3) very gravelly clay loam, brown (7.5YR 5/3) dry; moderate medium and fine subangular blocky structure; hard, firm, very sticky and plastic; many very fine roots; common very fine tubular pores; 40 percent pebbles; slightly acid; clear wavy boundary.

B21t-15 to 24 inches; dark brown (7.5YR 3/3) very gravelly clay loam, brown (7.5YR 5/3) dry; moderate medium and fine subangular blocky structure; hard, firm, very sticky and very plastic; common very fine and fine roots; common very fine tubular pores; few thin clay films on ped faces and in pores; 45 percent pebbles; slightly acid; clear wavy boundary.

B22t-24 to 34 inches; dark reddish brown (5YR 3/4) very gravelly clay, reddish brown (5YR 5/4) dry; moderate medium and fine subangular blocky structure; hard, firm, very sticky and very plastic; common very fine and fine roots; common very fine and fine tubular pores; many cutans on ped faces, thin clay films in pores; 50 percent pebbles; slightly acid; abrupt wavy boundary.

Cr-34 to 41 inches; dark gray (10YR 4/1) fractured volcanic tuff, light gray (10YR 7/1) dry; weathered in the upper few inches.

Soft bedrock is at a depth of 25 to 40 inches. The mollic epipedon is 20 to 30 inches thick. The argillic horizon has 35 to 70 percent rock fragments. The solum is slightly acid or neutral.

The A horizon has hue of 10YR or 7.5YR; value of 2 or 3, moist and 4 or 5, dry; and chroma of 2, moist and dry. The B2t horizon has hue of 5YR, 7.5YR, and 10YR; value of 3 or 4, moist and 4 to 6, dry; and chroma of 2 to 4, moist and dry. It is very gravelly clay loam or clay and has 35 to 45 percent clay.

Scherrard series

The Scherrard series consists of moderately deep, somewhat poorly drained soils on low terraces. These soils formed in alluvial and lacustrine sediment weathered partly from diatomite and tuff. Slopes are 0 to 1 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 50 degrees F. A water table is at a depth of 0 to 3.5 feet.

Typical pedon of Scherrard clay loam, in an area of irrigated pasture, near the southern end of Poe Valley, 1,850 feet east and 1,600 feet south of the northwest corner sec. 27, T. 39 S., R. 11 1/2 E.:

Ap-0 to 5 inches; black (10YR 2/1) clay loam, gray (10YR 5/1) dry; weak thin platy structure parting to moderate very fine angular blocky; hard, firm, very sticky and very plastic; many very fine roots; many very fine pores; strongly alkaline; abrupt wavy boundary.

A12-5 to 10 inches; black (10YR 2/1) silty clay, gray (10YR 5/1) dry; moderate fine angular blocky structure; hard, firm, very sticky and very plastic; many very fine roots; common very fine tubular pores; strongly effervescent in spots; strongly alkaline; clear wavy boundary.

B2tca-10 to 21 inches; black (10YR 2/1) silty clay, gray (10YR 5/1) dry, gray (10YR 6/1) rubbed and dry; common grayish brown (10YR 5/2) lime segregations; weak medium prismatic structure parting to moderate fine angular blocky; very hard, very firm, very sticky and very plastic; common very fine roots; common very fine tubular pores; many cutans on surfaces of peds; strongly effervescent; strongly alkaline; abrupt smooth boundary.

C1sim-21 to 27 inches; very dark grayish brown (10YR 3/2) duripan, light brownish gray (10YR 6/2) and light gray (10YR 7/1) dry; extremely hard, very firm; grayish brown (10YR 5/2) laminar opaline cap 1 millimeter to 2 millimeters thick at top of pan; thin opaline coatings on plate surfaces; strongly effervescent; strongly alkaline; clear wavy boundary.

C2sim-27 to 33 inches; dark grayish brown (10YR 4/2) duripan, light gray (10YR 7/1) dry; massive; very hard, firm and brittle; weakly effervescent; moderately alkaline; clear wavy boundary.

C3-33 to 60 inches; dark grayish brown (10YR 4/2) sandy loam, light gray (10YR 7/1) dry; massive; slightly hard, friable, nonsticky and nonplastic; many very fine roots; moderately alkaline.

Exchangeable sodium exceeds 15 percent in all or part of the upper 20 inches of the profile decreasing with increasing depth below 20 inches. The soil is calcareous at depths between 10 and 20 inches. The duripan is at a depth of 20 to 40 inches but depths between 20 to 30 inches predominate. The duripan is weakly to strongly cemented and is commonly platy. It has either some opal coatings on plate surfaces or a laminar opaline cap 1 millimeter or 2 millimeters thick, or both. The duripan commonly is 4 to 24 inches thick.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 0 or 1, moist and dry. It is clay loam, silty clay loam, silt loam, or very fine sandy loam. The B2t horizon has hue of neutral, 10YR, or 2.5Y; value of 2 or 3, moist and 4 to 6, dry; and chroma of 0 to 2, moist and dry. It commonly has many segregated lime mottles and is strongly alkaline or very strongly alkaline. It has 35 to 45 percent clay.

Shanahan series

The Shanahan series consists of very deep, somewhat excessively drained soils on terraces, benches, and escarpments. These soils formed in an ashy mantle over a loamy buried soil. Slopes are 1 to 45 percent. The mean annual precipitation is about 25 inches, and the mean annual air temperature is about 43 degrees F. The mean annual soil temperature is 42 to 45 degrees F, and the mean summer soil temperature without an O horizon is 52 to 59 degrees F.

Typical pedon of Shanahan gravelly loamy coarse sand, 1 to 12 percent slopes, in an area of woodland, about 1 mile northwest of Collier State Park, 1,800 feet west and 700 feet north of the southeast corner sec. 4, T. 34 S., R. 7 E.:

A1-0 to 4 inches; very dark grayish brown (10YR 3/2) gravelly loamy coarse sand, grayish brown (10YR 5/2) dry; weak very fine granular structure; soft, very friable, non sticky and nonplastic; many very fine roots; many very fine pores; 15 percent cinders 2 to 4 millimeters thick; slightly acid; clear wavy boundary.

AC1-4 to 8 inches; dark brown (10YR 3/3) gravelly coarse sand, pale brown (10YR 6/3) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine pores; 15 percent cinders 2 to 5 millimeters thick; slightly acid; clear wavy boundary.

AC2-8 to 15 inches; dark brown (10YR 4/3) gravelly coarse sand, yellow (10YR 8/6) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine and few fine roots; many very fine pores; 15 percent cinders 2 to 10 millimeters thick; slightly acid; clear wavy boundary.

C-15 to 26 inches; light olive brown (2.5Y 5/4) and light yellowish brown (2.5Y 6/4) coarse sand, pale yellow (2.5Y 7/4) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine and few fine roots; many very fine pores; 5 percent cinders 2 to 10 millimeters thick; many dark brown patches mixed from horizons above and below; slightly acid; clear wavy boundary.

IIB21b-26 to 34 inches; dark brown (7.5YR 4/4) fine sandy loam, brown (7.5YR 5/5) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few roots; many very fine pores; 10 percent hard lava pebbles and cobbles; neutral; abrupt wavy boundary.

IIB22b-34 to 45 inches; dark brown (7.5YR 4/4) fine sandy loam, brown (7.5YR 5/5) dry; massive; soft, very friable, nonsticky and nonplastic; few roots; many very fine pores; 5 percent hard lava pebbles; neutral; abrupt wavy boundary.

IIB23b-45 to 60 inches; dark brown (7.5YR 4/4) extremely cobbly fine sandy loam, brown (7.5YR 5/5) dry; massive; soft, very friable, nonsticky and nonplastic; few roots; many very fine pores; 70 percent cobbles and pebbles; neutral.

Bedrock is at a depth of more than 60 inches. The buried loamy soil is at a depth of 14 to 40 inches. The ash and cinders are pumiceous and dacitic. Cinders are 2 to 15 millimeters thick, predominantly are less than 8 millimeters thick, and are 10 to 35 percent of the ashy mantle.

The A1 horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 2, moist and 1 to 3, dry. The AC horizon has value of 3 to 5, moist and 5 or 6, dry and chroma of 2 to 6, moist and 1 to 4, dry. The C horizon has hue of 10YR to 5Y; value of 3 to 7, moist and 6 to 8, dry; and chroma of 1 to 6, moist and 0 to 4, dry. The IIB horizon has hue of 10YR to 5YR; value of 3 or 4, moist and 5 to 7, dry; and chroma of 2 to 4, moist and 1 to 4, dry. It is loam, fine sandy loam, or silt loam and has 12 to 18 percent clay. The lower part has 5 to 30 percent cobbles and 5 to 50 percent pebbles.

Steiger series

The Steiger series consists of very deep, somewhat excessively drained soils on terraces and lava plains. These soils formed in pumiceous ash. Slopes are 1 to 15 percent. The mean annual precipitation is about 30 inches, and the mean annual air temperature is about 43 degrees F. The mean annual soil temperature is 42 to 45 degrees F, and the mean summer soil temperature without an O horizon is 52 to 59 degrees F.

Typical pedon of Steiger loamy coarse sand, 1 to 15 percent slopes, in an area of woodland, about 1.5 miles east of the town of Fort Klamath, 2,400 feet north and 2,600 feet east of the southwest corner sec. 14, T. 33S., R. 7 1/2 E.:

A1-0 to 4 inches; very dark brown (10YR 2/2) loamy coarse sand, grayish brown (10YR 4/2) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine pores; 10 percent cinders; medium acid; abrupt wavy boundary.

AC1-4 to 10 inches; dark brown (10YR 3/3) gravelly loamy coarse sand, pale brown (10YR 6/3) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine pores; very slightly compact; 20 percent yellowish brown cinders; slightly acid; clear wavy boundary.

AC2-10 to 19 inches; dark yellowish brown (10YR 4/4) gravelly loamy coarse sand, pale brown (10YR 6/3) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine pores; very slightly compact; 20 percent yellowish brown cinders; neutral; gradual wavy boundary.

C1-19 to 29 inches; yellowish brown (10YR 5/4) gravelly coarse sand, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine pores; 30 percent yellowish brown cinders; pocket of dark yellowish brown AC2 material extends from the upper through the lower horizon boundaries; slightly acid; clear wavy boundary.

C2-29 to 35 inches; yellowish red (5YR 5/6) gravelly coarse sand, light reddish brown (5YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine pores; 20 percent cinders; slightly acid; gradual wavy boundary.

C3-35 to 60 inches; yellowish red (5YR 4/6) gravelly coarse sand, light reddish brown (5YR 6/3) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine pores; 20 percent cinders; neutral.

Bedrock is at a depth of more than 60 inches. Cinders are 2 millimeters to 5 centimeters thick and are 5 to 35 percent of the 10- to 40-inch control section. The fines are dacitic, pumiceous ash.

The A1 horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 2, moist and 1 or 2, dry. It has 5 to 25 percent cinders. The AC horizon has hue of 10YR to 5YR; value of 3 to 5, moist and 4 to 6, dry; and chroma of 2 to 4, moist and dry. Cinders mostly have chroma of 4 to 8. The C horizon has value of 3 to 6, moist and 6 or 7, dry and chroma of 4 to 8, moist and 2 to 6, dry. The cinders commonly have the higher chroma.

Stukel series

The Stukel series consists of shallow, well drained soils on rock benches. These soils formed in residual material weathered from tuff and diatomite. Slopes are 2 to 25 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 53 degrees F. The soil generally is dry, and it is dry at depths between 8 inches and the lithic contact for about 120 consecutive days during the 4-month period following June 21.

Typical pedon of Stukel loam, 2 to 15 percent slopes, in an area of rangeland, about 1 mile north of the town of Dairy, 2,000 feet south and 600 feet west of the northeast corner sec. 27, T. 38 S., R. 11 1/2 E.:

A1-0 to 7 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak thin platy structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; neutral; clear smooth boundary.

C-7 to 17 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak thick platy structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; neutral; abrupt smooth boundary.

R-17 inches; dark grayish brown (2.5Y 4/2) tuffaceous bedrock, light brownish gray (2.5Y 6/2) dry; continuous dark brown (10YR 3/3) coatings on surface of bedrock.

Bedrock is at a depth of 10 to 20 inches. The soil has 5 to 20 percent hard rock fragments 2 to 25 millimeters thick.

The A and C horizons have hue of 10YR or 7.5YR, value of 4 or 5, dry, and chroma of 2 or 3, moist and dry. They are loam and sandy loam and have 10 to 18 percent clay and 40 to 60 percent particles that are coarser than very fine sand.

Sycan series

The Sycan series consists of very deep, excessively drained soils on low terraces. These soils formed in alluvial deposits of pumiceous ash. Slopes are 0 to 2 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F. The mean summer soil temperature is 56 to 59 degrees F. A water table is at a depth of 5 to 7 feet.

Typical pedon of Sycan loamy sand, in an area of rangeland, about 0.5 mile south of the confluence of Snake Creek and Sycan River, near the center of SW1/ 4SW1/4 sec. 34, T. 35 S., R. 12 E.:

A1-0 to 5 inches; very dark grayish brown (10YR 3/2) loamy sand, light brownish gray (10YR 6/2) dry; weak medium platy structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine pores; neutral; clear smooth boundary.

AC-5 to 17 inches; very dark grayish brown (10YR 3/2) loamy coarse sand, light brownish gray (10YR 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine pores; neutral; gradual smooth boundary.

C1-17 to 30 inches; dark brown (10YR 3/3) loamy coarse sand, light gray (10YR 7/2) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine pores; mildly alkaline; clear wavy boundary.

C2-30 to 50 inches; dark brown (10YR 4/3) coarse sand, very pale brown (10YR 8/3) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine pores; mildly alkaline; gradual wavy boundary.

C3-50 to 60 inches; brown (10YR 5/3) and pale brown (10YR 6/3) coarse sand, light gray (10YR 7/2) dry; common dark reddish brown (5YR 3/4) mottles; massive; soft, very friable, nonsticky and nonplastic; many very fine pores; mildly alkaline.

Bedrock is at a depth of more than 60 inches. The 10 to 40-inch control section is 5 to 15 percent cinders 2 to 4 millimeters thick. Estimated bulk density is 0.4 to 0.8 gram per cubic centimeter. The soil is neutral or mildly alkaline.

The A horizon has value of 2 or 3, moist. It typically is loamy sand in the upper part and loamy coarse sand in the lower part. The C horizon has value of 3 to 6, moist and 6 to 8, dry and chroma of 3 or 4, moist and 2 or 3, dry. It is stratified loamy sand, loamy

Sycan Variant

The Sycan Variant consists of very deep, somewhat poorly drained soils on low terraces. These soils formed in alluvial deposits of pumiceous ash. Slopes are 0 to 2 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F, and the mean summer soil temperature is 56 to 59 degrees F.

Typical pedon of Sycan Variant loamy coarse sand, in an area of irrigated cropland, about 3 miles north of the town of Beatty, 1,320 feet east and 30 feet south of the northwest corner sec. 3, T. 36 S., R. 12 E.:

Ap-0 to 5 inches; very dark grayish brown (10YR 3/2) loamy coarse sand, gray (10YR 6/1) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine pores; weakly effervescent; strongly alkaline; clear wavy boundary.

AC1-5 to 11 inches; very dark grayish brown (10YR 3/2) loamy coarse sand, gray (10YR 6/1) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine pores; strongly alkaline; gradual wavy boundary.

AC2-11 to 21 inches; very dark grayish brown (10YR 3/2) loamy coarse sand, gray (10YR 6/1) and light gray (10YR 7/1) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine pores; moderately alkaline; gradual wavy boundary.

C1-21 to 29 inches; dark grayish brown (10YR 4/2) loamy coarse sand, gray (10YR 6/1) dry; few medium and coarse reddish brown (5YR 4/4) mottles; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine pores; neutral; abrupt wavy boundary.

IIC2-29 to 31 inches; light brownish gray (2.5Y 6/2) silt, light gray (10YR 7/1) dry; few fine gray (2.5Y 5/1) mottles; laminated; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; many very fine tubular pores; neutral; abrupt wavy boundary.

IIIC3-31 to 64 inches; light gray (10YR 7/2) and light brownish gray (10YR 6/2) coarse sand, light gray (10YR 7/1) and gray (10YR 6/1) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine pores; neutral.

Bedrock is at a depth of more than 60 inches. The 10to 40-inch control section has 5 to 15 percent cinders 2 to 4 millimeters thick. Estimated bulk density is 0.4 to 0.8 gram per cubic centimeter. The soil is moderately alkaline or strongly alkaline in the A horizon and neutral in the C horizon.

The A horizon has value of 2 or 3, moist. It is loamy coarse sand or loamy sand. The C horizon has value of 4 to 7, moist and 6 to 8, dry and chroma of 1 or 2, moist or dry. It is stratified loamy sand, loamy coarse sand, and coarse sand. A thin layer of silt or loam is in some pedons at a depth of below 25 inches. The soil is mottled at a depth below 20 inches.

Teeters series

The Teeters series consists of very deep, poorly drained soils on flood plains and drained lake bottoms. These soils formed in lacustrine sediment that contains diatoms. Slopes are 0 to 1 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 50 degrees F.

Typical pedon of Teeters silt loam, in an area of irrigated pasture, about 4 miles southeast of the town of Keno, 600 feet west and 200 feet north of the E1 /4 corner sec. 16 T. 40 S., R. 8 E.:

Ap-0 to 8 inches; black (10YR 2/1) silt loam, gray (10YR 5/1) dry, very dark gray (10YR 3/1) crushed; moderate medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; strongly effervescent; strongly alkaline; abrupt wavy boundary.

AC-8 to 16 inches; very dark gray (2.5Y 3/1) silt loam, gray (10YR 6/1) dry; few medium distinct dark yellowish brown (10YR 3/4) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; strongly effervescent; strongly alkaline; clear wavy boundary.

C1-16 to 30 inches; dark gray (5Y 4/1) silt, light gray (N 7/) dry; common distinct strong brown mottles in root channels; massive with horizontal cleavage; slightly hard, friable, nonsticky and nonplastic; common very fine roots; few very fine tubular pores; strongly effervescent; strongly alkaline; clear wavy boundary.

C2-30 to 36 inches; dark gray (N 4/) silt, light gray (N 7/) dry; common medium distinct dark yellowish brown (10YR 3/4) mottles; massive with horizontal cleavage; hard, friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; weakly effervescent; strongly alkaline; gradual wavy boundary.

C3-36 to 45 inches; dark gray (10YR 4/1) and very dark gray (10YR 3/1) silt loam, gray (10YR 6/1) dry, dark grayish brown (10YR 4/2) crushed; massive with horizontal cleavage; hard, firm, nonsticky and nonplastic; few very fine tubular pores; moderately alkaline; gradual irregular boundary.

C4-45 to 62 inches; dark gray (N 4/) silt, white (N 8/) dry; common medium faint very dark gray (2.5Y 3/1) mottles; massive with horizontal cleavage; hard, firm, nonsticky and nonplastic; few very fine tubular pores; moderately alkaline.

Bedrock is at a depth of more than 60 inches. The A horizon is strongly alkaline or very strongly alkaline; alkalinity decreases with depth below 20 inches in the profile. The soil is calcareous at depths between 10 and 20 inches. The mollic epipedon is 7 to 24 inches thick. Estimated bulk density is 0.4 to 0.7 gram per cubic centimeter. The soil has a high amount of diatoms and sponge spicules.

The A horizon has value of 2 or 3, moist and chroma of 0 or 1, moist or dry. The C horizon has hue of neutral, 10YR, 2.5Y, and 5Y; value of 2 to 6, moist and 4 to 8, dry; and chroma of 0 to 2, moist and dry. Mottles have value of 4 or 5, moist and chroma of 1 to 6.

Tulana series

The Tulana series consists of very deep, poorly drained soils on drained lake bottoms. These soils formed in lacustrine sediment that contains diatoms. Slopes are 0 to 1 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 48 to 50 degrees F.

Typical pedon of Tulana silt loam, in a cultivated field, about 500 feet south of the intersection of Center Canal and Klamath Straight Drain, 2,800 feet south and 200 feet west of the northeast corner sec. 31, T. 40 S., R. 9 E.:

Ap1-0 to 8 inches; black (10YR 2/1) silt loam, gray (10YR 5/1) dry; weak very fine granular structure; soft, friable, slightly sticky and nonplastic; many very fine roots; many very fine pores; neutral; abrupt smooth boundary.

Apt-8 to 23 inches; black (N 2/) silt loam, gray (N 5/) and few flecks of light gray (N 7/) dry, gray (10YR 6/1) rubbed and dry; weak fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; neutral; abrupt smooth boundary.

C1-23 to 37 inches; grayish brown (2.5Y 5/2) silt, light gray (10YR 7/1) dry; common faint dark grayish brown (2.5Y 4/2) mottles; moderate very thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few very fine tubular pores; neutral; abrupt smooth boundary.

C2-37 to 46 inches; dark brown (7.5YR 3/2) mucky silt, gray (10YR 6/1) dry; common fine distinct dark gray and strong brown mottles; weak thin platy structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; few very fine tubular pores; neutral; abrupt smooth boundary.

C3-46 to 57 inches; grayish brown (10YR 5/2) silt, light gray (10YR 7/2) dry; common strong brown (7.5YR 5/6) mottles; weak very thin platy structure; slightly hard, friable, slightly sticky and nonplastic; few roots; few very fine tubular pores; slightly acid; abrupt smooth boundary.

IIC4-57 to 64 inches; grayish brown (10YR 5/2) very fine sandy loam, light gray (10YR 7/2) dry; common fine strong brown mottles and black streaks and spots; massive; soft, very friable, slightly sticky and nonplastic; few roots; many very fine pores; medium acid; abrupt smooth boundary.

IIIC5-64 to 82 inches; grayish brown (2.5Y 5/2) silt loam, light gray (10YR 7/2) dry; common strong brown (7.5YR 5/6) mottles, common black flecks and patches; weak very thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; few roots; few very fine tubular pores; medium acid; abrupt smooth boundary.

IVC6-82 to 86 inches; dark grayish brown (2.5Y 4/2) fine sand, gray (10YR 6/1) dry; common fine strong brown mottles; massive; soft, very friable, nonsticky and nonplastic; few roots; many very fine pores; medium acid; abrupt smooth boundary.

VC7-86 to 92 inches; olive gray (5Y 4/2) silt loam, light gray (10YR 7/1) dry; common fine strong brown mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine pores; medium acid.

The soil is ponded under natural conditions. The upper part of the soil is slightly acid to mildly alkaline; the lower part is slightly acid to very strongly acid. The mollic epipedon is 7 to 20 inches thick. Estimated bulk density is 0.4 to 0.7 gram per cubic centimeter. The soil has a high amount of diatoms, sponge spicules, and amorphous material. Muck layers that are 4 to 10 inches thick are common at a depth below 20 inches. Pumiceous ash layers that are 1 inch to 4 inches thick are common at a depth of below 30 inches.

The A horizon has hue of neutral or 10YR, value of 4 or 5, dry and chroma of 0 or 1, moist and dry. The C horizon has hue of 10YR, neutral, 2.5Y, and 5Y; value of 2 to 5, moist and 5 to 8, dry; and chroma of 0 to 2, moist and dry. The C horizon below a depth of 40 inches is fine sand in many pedons.

Tutni series

The Tutni series consists of very deep, moderately well drained soils in swales and depressions on tablelands. These soils formed in ash and cinders. Slopes are 0 to 3 percent. The mean annual precipitation is about 25 inches, and the mean annual air temperature is about 43 degrees F. The mean annual soil temperature is 42 to 45 degrees F, and the mean summer soil temperature without an O horizon is 52 to 59 degrees F. A water table is at a depth of 3.5 to 5 feet.

Typical pedon of Tutni coarse sandy loam, in an area of woodland, about 6 miles east of the town of Fort

Klamath, 800 feet west and 1,450 feet south of the northeast corner sec. 21, T. 33 S., R. 7 E.:

O1-1/2 inch to 0; conifer needle mat, partly decomposed in lower part.

A1-0 to 3 inches; very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) coarse sandy loam, grayish brown (10YR 5/2) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine pores; 10 percent cinders; strongly acid; clear wavy boundary,

AC1-3 to 10 inches; dark brown (10YR 3/3) loamy coarse sand, pale brown (10YR 6/3) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine pores; 15 percent cinders; slightly acid; gradual wavy boundary.

AC2-10 to 19 inches; dark brown (7.5YR 4/4) loamy coarse sand, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine pores; 15 percent cinders; slightly acid; gradual wavy boundary.

C1-19 to 30 inches; brown (7.5YR 5/4) and strong brown (7.5YR 5/6) loamy coarse sand, light brown (7.5YR 6/4) dry; many medium faint pinkish gray (7.5YR 6/2) mottles; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine pores; 10 percent cinders; neutral; gradual wavy boundary.

C2-30 to 41 inches; brown (7.5YR 5/4) loamy coarse sand, pink (7.5YR 7/4) dry; common medium distinct pinkish gray (7.5YR 6/2) mottles; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; many very fine pores; 10 percent cinders; neutral; gradual wavy boundary.

C3-41 to 60 inches; reddish brown (5YR 5/4) loamy coarse sand, pink (7.5YR 7/4) dry; few medium distinct pinkish gray (7.5YR 6/2) mottles; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; many very fine pores; 10 percent cinders; neutral.

Bedrock is at a depth of more than 60 inches. The ash and cinders are pumiceous and dacitic. The soil has 5 to 35 percent cinders 2 to 76 millimeters thick.

The A1 horizon has hue of 10YR or 7.5YR, moist and dry, value of 4 or 5, and chroma of 2 or 3, dry. It is coarse sandy loam or loamy coarse sand. The AC horizon has hue of 10YR or 7.5YR, value of 2 to 4, moist and 4 to 6, dry and chroma of 2 to 4, moist and dry. The C horizon has hue of 5YR to 2.5Y, value of 3 to 6, moist and 5 to 7, dry and chroma of 2 to 6, moist and 2 to 4, dry.

Woodcock series

The Woodcock series consists of very deep, well drained soils on escarpments and glacial outwash plains. These soils formed in very gravelly colluvium and outwash weathered from lava rocks. Slopes are 1 to 60 percent. The mean annual precipitation is about 22 inches, and the mean annual air temperature is about 42 degrees F. The mean annual soil temperature is 41 to 47 degrees F, and the mean summer soil temperature without an O horizon is 51 to 59 degrees F.

Typical pedon of Woodcock stony loam, 5 to 40 percent south slopes, in an area of woodland, on Doak Mountain, 990 feet north and 330 feet east of the southwest corner sec. 14, T. 37 S., R. 7 E.:

O1-1/2 inch to 0; loose litter of needles, leaves, cones, and roots.

A1-0 to 2 inches; very dark brown (7.5YR 2/2) stony loam, dark brown (7.5YR 4/2) dry; weak fine and very fine granular structure; soft, very friable, slightly sticky and slightly plastic; many roots; many very fine pores; slightly acid; clear smooth boundary.

A3-2 to 10 inches; dark reddish brown (5YR 3/3) very gravelly loam, brown (7.5YR 5/3) dry; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; many roots; common very fine tubular pores; neutral; gradual smooth boundary.

B1-10 to 17 inches; dark reddish brown (5YR 3/3) extremely gravelly loam, brown (7.5YR 5/3) dry; weak medium subangular blocky structure; hard, friable, sticky and slightly plastic; many roots; few very fine tubular pores; slightly acid; gradual smooth boundary.

IIB21t-17 to 26 inches; dark reddish brown (5YR 3/4) extremely gravelly clay loam, reddish brown (5YR 5/ 4) dry; weak fine subangular blocky structure; hard, friable, sticky and plastic; common roots; few fine and very fine tubular pores; few thin clay films on pebbles; neutral; clear smooth boundary.

IIB22t-26 to 48 inches; dark reddish brown (5YR 3/3) extremely gravelly clay loam, brown (7.5YR 5/3) dry, dark reddish brown (5YR 3/4) crushed; weak fine and medium subangular blocky structure; hard, friable, sticky and plastic; common roots; many fine tubular pores; common thin clay films on pebbles and few thin clay films on peds and in pores; slightly acid; gradual smooth boundary.

IIC-48 to 66 inches; dark reddish brown (5YR 3/4) extremely cobbly loam, brown (7.5YR 5/4) dry; massive; hard, friable, slightly sticky and slightly plastic; common roots; common very fine tubular pores; slightly acid.

The mollic epipedon is 16 to more than 30 inches thick. Bedrock is at a depth of more than 60 inches.

The A horizon has hue of 10YR to 5YR; value of 2 or 3, moist and 4 or 5, dry; and chroma of 2 or 3, moist and 1 to 3, dry. It has 15 to 35 percent pebbles and 0 to 15 percent cobbles and stones. This horizon has appreciable volcanic glass and many weathered plagioclase grains 1 millimeter to 2 millimeters thick. The B2t horizon has hue of 10YR to 5YR; value of 2 to 4, moist and 4 to 6, dry; and chroma of 2 to 4, moist and dry. It is very gravelly or extremely gravelly loam or clay loam. It has 25 to 35 percent clay, 45 to 55 percent pebbles, and 5 to 20 percent cobbles and stones.

Xerofluvents

Xerofluvents consists of very deep, moderately well drained soils on flood plains. These soils formed in sandy and silty alluvium dredged from the bottom of the Klamath River. Slopes are 0 to 1 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean annual soil temperature is 47 to 51 degrees F. The soil is moistened at a depth of below 30 inches by a water table. It is dry throughout at depths between 8 and 24 inches for 90 to 120 days in the 4-month period following June 21.

Reference pedon of Xerofluvents, in an area of irrigated cropland, about 2 miles southeast of the town of Keno, 1,240 feet east and 700 feet north of the southwest corner sec. 9, T. 40 S., R. 8 E.:

Ap-0 to 7 inches; dark grayish brown (2.5Y 4/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine pores; strongly acid; abrupt smooth boundary.

C1-7 to 21 inches; dark grayish brown (2.5Y 4/2) loamy fine sand, light brownish gray (2.5Y 6/2) dry; weak thin platy structure; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine pores; strongly acid; clear smooth boundary.

IIC2-21 to 44 inches; very dark gray (5Y 3/1) silt loam, gray (2.5Y 6/1) dry; weak thin platy structure; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; many very fine pores; neutral; abrupt smooth boundary.

IIIAb-44 to 64 inches; black (10YR 2/1) diatomaceous silt, gray (2.5Y 6/1) dry; massive; slightly hard, firm, slightly sticky and nonplastic; few very fine roots; many very fine pores; neutral.

The sandy upper part of the soil is about 10 to 40 inches thick. Depth to the buried soil is 20 to 60 inches. The 10- to 40-inch control section has 0 to 10 percent fine pebbles. The sandy upper part of the soil is medium acid and strongly acid. The buried soil is neutral to strongly alkaline.

The A horizon has value of 3 or 4, moist and 6 or 7, dry. The C horizon has value of 3 or 4, moist. It is loamy fine sand and loamy sand. The IIC horizon has value of 2 to 4, moist. It is silt loam and very fine sandy loam. The IIIAb horizon has value of 4 to 6, dry and chroma of 0 or 1, moist and dry. It is silt and silt loam.

Yainax series

The Yainax series consists of moderately deep, well drained soils on benches and pediments. These soils formed in material weathered mainly from diatomite. Slopes are 1 to 15 percent. The mean annual precipitation is about 17 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F. The soil generally is moist, but it is dry at depths between 4 and 12 inches for 65 to 90 days during the 4-month period following June 21.

Typical pedon of Yainax loam, 1 to 15 percent slopes, in an area of woodland, about 2 miles southwest of Council Butte, 2,100 feet west and 1,350 feet south of the northeast corner sec. 35, T. 36 S., R. 11 E.:

O1-1 inch to 0; loose mat of pine needles, partly decomposed in lower part.

A1-0 to 5 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/1) dry; weak thin platy structure parting to weak very fine granular; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; 25 percent ash; slightly acid; abrupt wavy boundary.

A2-5 to 14 inches; dark grayish brown (10YR 4/2) loam, light gray (10YR 7/2) with few fine brown flecks dry; weak medium and fine angular blocky structure; slightly hard, friable, sticky and slightly plastic; many roots; many very fine tubular pores; 10 percent ash; nearly continuous bleached silt coatings on peds; slightly acid; clear wavy boundary.

A&B-14 to 24 inches; dark brown (10YR 4/3) clay loam, light gray (10YR 7/2) with many flecks and patches of light yellowish brown (10YR 6/4) dry; moderate medium and fine angular blocky structure; hard, firm, sticky and plastic; many roots; many very fine tubular pores; many bleached silt coatings on surfaces of peds; few thin clay films on peds; slightly acid; clear wavy boundary.

B&A-24 to 31 inches; dark brown (10YR 4/3) and brown (10YR 5/3) clay loam, yellowish brown (10YR 5/4) dry, thick tongues and coatings of light gray (10YR 7/2) dry; strong medium and fine angular blocky structure; very hard, firm, sticky and plastic; many roots to a depth of 27 inches, common roots to a depth of 31 inches; many very fine tubular pores; many moderately thick clay films on peds and thin clay films in pores; many soft pebbles of diatomite, 10 percent hard lava pebbles and cobbles; slightly acid; clear wavy boundary.

Cr-31 to 37 inches; very pale brown (10YR 7/3) and yellowish brown (10YR 5/4) diatomite breccia, white (N 8/) and very pale brown (10YR 7/3) dry; breccia consists mainly of subangular diatomite fragments.

Soft bedrock is at a depth of 20 to 40 inches. The solum is slightly acid or neutral.

The A1 horizon has value of 5 or 6, dry and 2 or 3, moist. It is less than 4 inches thick where value is 5, dry. The A horizon has 5 to 20 percent pebbles. The Bt horizon has value of 4 or 5, moist and 5 to 7, dry and chroma of 2 to 4, dry. The bleached silt coatings on the faces and interiors of peds mainly have value of 6 or 7. This horizon has 27 to 35 percent clay and more than 15 percent particles that are coarser than very fine sand, 0 to 30 percent soft diatomaceous pebbles, 5 to 30 percent pebbles, and 0 to 5 percent cobbles of unweathered hard lava.

Yancy series

The Yancy series consists of shallow, well drained soils on terraces, benches, and tablelands. These soils formed in gravelly sediment weathered from basalt, tuff, and felsite. Slopes are 0 to 8 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 46 degrees F. The soil generally is moist, but it is dry at depths between 4 and 12 inches for 75 to 90 days during the 4-month period following June 21.

Typical pedon of Yancy clay loam, 0 to 2 percent slopes, in an area of rangeland, about 1.5 miles south of the town of Sprague River, 2,100 feet north and 3,200 feet east of the southwest corner sec. 22, T. 36 S., R. 10 E.:

A1-0 to 2 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; weak thin platy structure; slightly hard, friable, sticky and plastic; common very fine roots; many very fine pores; 50 percent cover of fine pebbles on surface; neutral; clear wavy boundary.

B1t-2 to 6 inches; very dark grayish brown (10YR 3/2) clay loam, brown (10YR 5/3) dry, dark brown (10YR 3/3) rubbed; weak medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; common very fine tubular pores; 15 percent pebbles; common thin clay films on peds and pebbles and in pores; neutral; clear wavy boundary.

B21t-6 to 12 inches; dark brown (10YR 3/3) gravelly clay, brown (10YR 5/3) dry; moderate fine subangular blocky structure; very hard, very firm, very sticky and very plastic; common very fine roots; many very fine tubular pores; 20 percent pebbles; many stress cutans on peds, thick clay films on pebbles, and thin clay films in pores; neutral; clear wavy boundary.

B22t-12 to 14 inches; dark yellowish brown (10YR 4/4) very gravelly clay, yellowish brown (10YR 5/4) dry; moderate fine angular blocky structure; very hard, very firm, very sticky and very plastic; common very fine roots; many very fine tubular pores; 40 percent pebbles; nearly continuous stress cutans on peds, thick clay films on pebbles and thin clay films in pores; neutral; abrupt smooth boundary.

Csim-14 to 60 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) very gravelly duripan, yellow (10YR 8/6) dry; massive; indurated to a depth of 24 inches, strongly cemented to a depth of 60 inches; white (10YR 8/2) dry, opaline cap 2 to 10 millimeters thick at top of duripan.

The duripan is at a depth of 12 to 20 inches. It is 1 foot to more than 4 feet thick and has an indurated opaline cap 1 millimeter to more than 1 centimeter thick. Bedrock is at a depth of more than 60 inches. The Bt horizon has 5 to 25 percent pebbles but may have as much as 40 percent in some thin subhorizons.

The A horizon has value of 2 or 3, moist and 4 or 5, dry and chroma of 2, moist and 1 or 2, dry. The B2t horizon has value of 2 or 3, moist in the upper part and 3 or 4 in the lower part and 4 or 5, dry and chroma of 2 to 4, moist and 2 or 3, dry. The Bt horizon has 35 to 50 percent clay and 20 to 40 percent particles that are coarser than very fine sand.

Yawhee series

The Yawhee series consists of very deep, somewhat excessively drained soils on volcanic cones and cuestas. These soils formed in colluvium of volcanic ash and buried very gravelly loamy material. Slopes are 3 to 40 percent. The mean annual precipitation is about 22 inches, and the mean annual air temperature is about 43 degrees F. The mean soil temperature is 42 to 45 degrees F, and the mean summer soil temperature without an O horizon is 52 to 59 degrees F.

Typical pedon of Yawhee stony coarse sandy loam, 3 to 45 percent slopes, in an area of woodland, about 2 miles northwest of Swan Lake Point, 2,545 feet west and 900 feet north of the southeast corner sec. 19, T. 36 S., R. 9 E.:

O1-1/2 inch to 0; loose mat of pine and fir needles.

A11-0 to 2 inches; very dark grayish brown (10YR 3/2) stony coarse sandy loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; soft, very friable, slightly sticky and nonplastic; many roots; many very fine pores; 15 percent pebbles and 5 percent stones; slightly acid; clear wavy boundary.

A12-2 to 13 inches; very dark grayish brown (10YR 3/2) very cobbly coarse sandy loam, grayish brown

(10YR 5/2) dry; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; many roots; many very fine pores; 20 percent pebbles and 20 percent cobbles and stones; slightly acid; clear wavy boundary.

C-13 to 28 inches; dark yellowish brown (10YR 3/4) very cobbly loamy coarse sand, brown (10YR 5/3) dry; massive; soft, very friable, nonsticky and nonplastic; many roots; many very fine pores; 25 percent pebbles and 25 percent cobbles and stones; slightly acid; clear wavy boundary.

IIA1b-28 to 37 inches; dark brown (10YR 3/3) very gravelly fine sandy loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; many roots; many very fine pores; 35 percent pebbles and 10 percent cobbles and stones; slightly acid; clear wavy boundary.

IIB21tb-37 to 50 inches; dark brown (10YR 3/3) very gravelly loam, brown (10YR 5/3) dry; common fine and medium angular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; few thin clay films on peds; 55 percent pebbles and 5 percent cobbles; slightly acid; clear smooth boundary.

IIB22tb-50 to 60 inches; dark brown (10YR 3/3) very gravelly loam, brown (10YR 5/3) dry; common fine and medium angular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; common very fine pores; 55 percent pebbles and 10 percent cobbles and stones; slightly acid.

Bedrock is at a depth of more than 60 inches. Colors that are dark enough for a mollic epipedon extend to a depth of 10 to 15 inches, and estimated bulk density of the epipedon is about 0.6 gram per cubic centimeter. The ashy upper part is 14 to 35 inches thick, and the fines have 60 to 70 percent pumiceous ash. The soil has hue of 10YR to 5YR, moist and 10YR or 7.5YR, dry throughout. It is also slightly acid or neutral throughout.

The A1 horizon has value of 2 or 3, moist and 3 to 5,

dry and chroma of 2 or 3, moist and 2 to 4, dry. Some of the coarse and very coarse sand grains have value of 4, moist and 6, dry and chroma of 4 to 6, moist and 4, dry. This horizon has 10 to 30 percent cobbles and stones. The C horizon has value of 5 or 6, dry and chroma of 3 or 4, moist. Coarse and very coarse sand grains have value of 4, moist and 6, dry and chroma of 4 to 6, moist and 4, dry. This horizon has 15 to 30 percent pebbles and 20 to 35 percent cobbles and stones. The IIAb horizon has value of 4 or 5, dry and chroma of 2 or 3, moist. It is gravelly loam or very gravelly fine sandy loam and has 15 to 35 percent pebbles and 0 to 15 percent cobbles and stones. This horizon is absent in some pedons. The IIBtb horizon has value of 4 or 5, dry and chroma of 2 to 4, moist and 2 or 3, dry. It is very gravelly and is loam or clay loam. It has 20 to 30 percent clay, 45 to 55 percent pebbles, and 5 to 20 percent cobbles and stones.

Yonna series

The Yonna series consists of very deep, poorly drained soils on flood plains. These soils formed in mixed alluvium that includes ash. Slopes are 0 to 2 percent. The mean annual precipitation is about 16 inches, and the mean annual air temperature is about 44 degrees F. The mean annual soil temperature is 44 to 47 degrees F, and the mean summer soil temperature is 56 to 59 degrees F. A water table is at a depth of about 2 feet during spring.

Typical pedon of Yonna loam, in an area of rangeland, about 1 mile west of the town of Beatty, 515 feet west and 66 feet south of the northeast corner sec. 21, T. 36

A11-0 to 5 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) dry; weak very thin platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine pores; strongly effervescent; 15 percent visible ash; very strongly alkaline; abrupt wavy boundary.

A12-5 to 11 inches; very dark grayish brown (10YR 3/2) loam, gray (10YR 6/1) dry; weak thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; strongly effervescent; 20 percent visible ash; very strongly alkaline; clear wavy boundary.

B21-11 to 20 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots to a depth of 16 inches, common roots to a depth of 20 inches; common very fine tubular pores; weakly effervescent; 30 percent visible ash; moderately alkaline; clear wavy boundary.

B22-20 to 29 inches; dark brown (10YR 3/3) sandy loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common roots; many very fine and fine tubular pores; 40 percent visible ash; neutral; abrupt smooth boundary.

IIA1b-29 to 35 inches; dark brown (10YR 3/3) clay loam, light gray (10YR 7/2) dry; common fine distinct dark brown and dark reddish brown mottles; weak medium and fine angular blocky structure; slightly hard, friable, sticky and slightly plastic; common roots; many very fine and fine tubular pores; 15 percent visible ash; neutral; clear wavy boundary.

IIB2b-35 to 55 inches; dark brown (10YR 4/3) clay loam, light gray (10YR 7/2) dry; many fine distinct dark reddish brown mottles; weak medium and fine angular blocky structure; hard, firm, sticky and slightly plastic; few roots; many very fine and fine tubular pores; 10 percent ash; neutral; abrupt smooth boundary.

IIIC-55 to 61 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam, white (10YR 8/2) dry; many fine distinct dark reddish brown and common medium faint grayish brown (2.5Y 5/2) mottles; massive; slightly hard, very friable, slightly sticky and nonplastic; few roots; many very fine pores; neutral.

Bedrock is at a depth of more than 60 inches. The upper part of the soil has 15 to 60 percent 'pumiceous ash 0.5 millimeters thick, and estimated moist bulk density is 0.6 gram per cubic centimeter. The soil is strongly alkaline or very strongly alkaline in half or more of the upper 20 inches and decreases in alkalinity at a depth of below 20 inches. It is calcareous at depths between 10 and 20 inches. The buried soil has 18 to 30 percent clay and more than 15 percent particles that are coarser than very fine sand.

The A horizon has value of 3 or 4, moist and 6 or 7, dry and chroma of 1 or 2, moist and dry. It is loam or coarse sandy loam. The B horizon has value of 3 to 5, moist and 6 to 8, dry and chroma of 1 to 3, moist and dry. It is loam or sandy loam. The IIA and IIB horizons have hue of 10YR or 2.5Y; value of 3 or 4, moist and 6 or 7, dry; and chroma of 2 or 3, moist and dry. They are clay loam, loam, and very fine sandy loam.

Zuman series

The Zuman series consists of very deep, poorly drained, sodic soils on lakebeds and flood plains. These soils formed in lacustrine sediment weathered from tuff, diatomite, and basalt. Slopes are 0 to 1 percent. The mean annual precipitation is about 12 inches, and the mean annual air temperature is about 48 degrees F. The mean soil temperature is 48 to 50 degrees F. A water table is at a depth of 0 to 4 feet.

Typical pedon of Zuman silty clay loam, in an area of saltgrass pasture, about 15 miles south of Klamath Falls on the bottom of Miller Lake, about 10 feet north of the Oregon-California State Line, 3,400 feet east and 2,400 feet south of the northwest corner sec. 15, T. 41 S., R. 8 E.:

A1-0 to 4 inches; dark grayish brown (10YR 4/2) silty clay loam, gray (10YR 6/1) dry; weak very fine subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine roots; common very fine tubular pores; strongly effervescent; very strongly alkaline; clear wavy boundary.

C1-4 to 13 inches; gray (5Y 6/1) silty clay loam, light gray (5Y 7/1) dry; common medium faint dark gray (10YR 4/1) mottles; moderate medium platy structure; slightly hard, friable, sticky and plastic; common very fine roots; common very fine tubular pores; strongly effervescent; very strongly alkaline; clear wavy boundary.

C2-13 to 17 inches; grayish brown (5Y 5/2) sandy clay loam, light gray (5Y 7/2) dry; common medium faint dark gray (10YR 4/1) mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine pores; strongly effervescent; very strongly alkaline; clear wavy boundary.

IIC3-17 to 24 inches; very dark gray (N 3/) and dark grayish brown (2.5Y 4/2) fine sand, grayish brown (2.5Y 5/2) dry; many medium faint dark gray (N 4/) mottles; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine pores; weakly effervescent; very strongly alkaline; abrupt smooth boundary.

IIC4-24 to 30 inches; very dark gray (N 3/) fine sand, dark grayish brown (2.5Y 4/2) dry; many medium distinct olive brown (2.5Y 4/4) mottles; massive; soft, very friable, nonsticky and nonplastic; many very fine pores; weakly effervescent; very strongly alkaline; clear wavy boundary.

IIC5-30 to 37 inches; black (10YR 2/1) fine sand, dark gray (10YR 4/1) dry; common medium distinct olive brown (2.5Y 4/4) mottles; massive; hard, firm, nonsticky and nonplastic; many very fine pores; weakly effervescent; compact layer that slakes readily in water; very strongly alkaline; clear wavy boundary.

IIC6-37 to 60 inches; black (N 2/) fine sand, dark gray (N 4/) dry; massive; hard, firm, nonsticky and nonplastic; many very fine pores; weakly effervescent; compact layer that slakes readily in water; very strongly alkaline.

Exchangeable sodium exceeds 15 percent in all or part of the upper 20 inches of the profile and may increase or decrease with depth below 20 inches. The IIC horizon has 40 to 80 percent mafic mineral.

The A1 horizon has value of 3 or 4, moist and 6 or 7,dry and chroma of 0 to 2, moist and dry. It is silty clay loam, silt loam, and loamy fine sand. The C horizon has hue of 2.5Y, 5Y, neutral, and 10YR. The C horizon has value of 4 to 6, moist and 6 or 7, dry and chroma of 0 to 2, moist and dry in the matrix. This horizon is silty clay loam, clay loam, and sandy clay loam. Mottles have value of 3 or 4 and chroma of 0 to 4, moist. The IIC horizon has value of 2 to 4, moist and 4 or 5, dry and chroma of 0 to 2, moist and dry.

Classification of the soils

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" (24).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 22, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Orthent (*Orth*, meaning true, plus *ent,* from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Cryorthents (Cry/, meaning icy cold, plus *orthent,* the suborder of Entisols.

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Cryorthents.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a single or series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is cindery Cryorthent.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition. An example is Lapine.

Formation of the soils

This section discusses the factors and processes which formed the soils in the Area, and which gave them many of their distinctive characteristics. Soils, as used in this discussion and report, are dimensioned segments of landscape composed of unconsolidated materials capable of supporting such higher plants as trees, shrubs, and grasses.

Soils are formed through the interaction of five major factors: climate, plant and animal life, parent material, relief, and time. The relative influence of each factor varies from place to place, and in some places a single factor can determine most properties of the soil. Parent material and relief cause most of the differences in the soils of the survey. Man also has influenced the differences in soils. He has diked and drained large areas of marsh, made excavations for gravel and roadfill, cut and filled the land in leveling for irrigation, and created an acreage of new soil along the Klamath River by dredging.

Climate

The survey area has climatic variations that range from warm and semiarid in the southerly basins to cold and humid on mountain slopes and in the Cascade Mountains. Marked changes in climate are produced within short distances by changes in elevation, percentage of slope, and the direction in which the slope faces. Basins in the southern part of the survey area, for example, Klamath Valley, are warmer and drier than those in the northern part, such as the Sprague River and Wood River Valleys.

The coldest part of the survey area, which is in the north, was covered with a thick mantle of pumiceous ash and cinders by the eruption that formed Crater Lake about 6,500 years ago (28). The average annual precipitation is between 18 to 35 inches, and the average annual air temperature is between 41 to 45 degrees F for this part of the survey area.

The thermal properties of pumice soils cause large differences in temperature at the surface of the soil from daytime to nighttime. The pumice soils, for example, Lapine, Shanahan, and Steiger soils, absorb and hold little heat from solar radiation and have little heat to release at night to prevent frost (5, 7). The hazard of frost in this part of the survey area is increased significantly because of the thermal properties of these soils.

Only slight mechanical and physical weathering of the pumice has occurred in these soils since the eruptions that produced them. The coarse ash and cinders mostly appear fresh and unweathered, and only a small percentage of amorphous clay has been produced by weathering. By contrast, where the pumice has been washed onto flood plains of the poorly drained Ontko and Dilman soils, the coarse pumice grains are highly weathered in the A horizon and can readily be rubbed to clay with the fingers.

Most of the basins in the survey area have average annual precipitation between 10 to 18 inches and average annual air temperature between 42 to 49 degrees F (11). The intensity of physical and chemical weathering is very slight under these conditions. Hard rock fragments of Pliocene basalt and andesite appear fresh and unweathered on the surface throughout the profile of such soils as Lorella and Dehlinger. Only such soft rocks as diatomite and tuff appear to weather readily to clay.

The timbered escarpments that make up most of the remaining part of the survey area have average annual precipitation of about 18 to 25 inches and average annual air temperature of 40 to 45 degrees F (11). These areas are in a zone of moderate chemical weathering and frost action (18). Hard rock fragments of Pliocene andesite mostly appear fresh and unweathered in the profile of Woodcock soils, but some fragments in the lower part of the profile may have thin weathering rinds.

At higher elevations and on north-facing slopes, continuous wide bands of talus lie along the base of very steep slopes. Mechanical weathering, mainly frost riving, of the capping lavas on the escarpments produced this talus.

Alpine glaciation was prominent in the eastern Cascade Mountains and on many volcanic cones near the survey area. One soil, Woodcock gravelly loam, formed in glacial outwash. Evidence exists that a periglacial climate was over many parts of the survey area. Jagged, frost-riven rimrocks at the base of which lie thick accumulations of angular blocks and fragments of talus, block fields, and felsemeer (sea of stones) on tablelands, and much patterned land on tablelands consisting of soil mounds, stone rings, stone garlands, and stone stripes, all show evidence of such a climate. The accordant summit levels of the mounds seem to indicate that they are remnants of a former uniform soil mantle, possibly of volcanic ash origin. The mound soil is underlain by an indurated duripan and mostly has a strongly expressed illuvial subsoil.

One plausible origin for these mounds is the development of ice wedge polygons where the frost line penetrated the saturated soil to the duripan. With seasonal warming and moderation of the climate, the soil above the wedges slumped into cavities left by the melting ice. Solifluction, aided by melting conditions and precipitation, carried away the slumped materials and gradually created a network of trenches which eventually segmented the areas into mounds (12). The Ponina-Rock outcrop complex has extensive areas of patterned land.

Most of the precipitation in the survey area is from October to March and is sufficient to moisten the soil to a depth of more than 5 feet. Free carbonates are leached from the soils below the rooting depth of plants and are present in only a few places in the Calimus and Harriman soils, mostly a few inches above bedrock. Except if they are irrigated, for many years the soils in the semiarid warmer basins have been well supplied with bases such as calcium, magnesium, and potassium.

Plant and animal life

Living organisms, including higher plants, bacteria, fungi, protozoa, insects, and burrowing animals, are important to soil formation. The decaying roots of grass, shrubs, and trees supply organic matter to the soil, particularly the upper part, and impart a dark color to it. Falling needles and cones from conifer trees, leaves from shrubs, and other plants decompose and eventually recycle nutrients that are used by these plants to the soil.

Bacteria, fungi, and protozoa decompose much of the dead plant remains and aid in returning nutrients to the soil and in converting them to stable forms of organic matter. Earthworms, ants, and burrowing animals, for example, badgers, rock chucks, ground squirrels, and gophers, are active in mixing soil horizons in many soils where moisture conditions are favorable. Such animals as badgers and gophers, however, do not burrow deeply into soils that have a high amount of rock fragments, particularly cobbles and stones. Earthworms also are not numerous in the survey area except in irrigated soils, gardens, and lawns.

Man has had an extensive, though recent, influence in modifying soil properties, by removing parts of soils from the landscape, and creating new areas of soils. It is estimated that more than 100,000 acres in the survey area has been leveled and smoothed for irrigation. The process of leveling commonly removes a portion of the upper part of the soil on higher spots and deposits and material on lower spots. The heavy machinery that is used in leveling also compacts the soil.

Many excavations have been made for roadfill, topsoil, gravel, and sand to create level sites for dwellings and buildings. Large areas of marsh were reclaimed by diking and draining to create the Lather soil around Upper Klamath Lake and the Tulana soils on Lower Klamath Lake. Plowing to a depth of 2 to 3 feet has mixed and altered the upper part of many areas of Tulana soils. Slight salinization of some areas of the these soils is taking place as a result of subirrigation.

A new soil, Xerofluvents, was created in 1971 by hydraulic dredging of material from the bed of the Klamath

River and by depositing this material on the river flood plain. Some soils that have a duripan have been altered by deep ripping to break up the pans. Intensive fertilization and irrigation on many Fordney soils have changed the reaction of the upper part of the soil from neutral or slightly acid to strongly acid or very strongly acid. Irrigation and drainage also have redistributed carbonates in the Laki, Henley, and Poe soils, and have decreased their salt and sodium contents.

Parent material

Parent material is the unconsolidated mineral or organic matter in which soils form. Many distinctive kinds of parent material have influenced the formation and properties of soils in the survey area. The influence of parent material in soil formation can be profound where materials are contrasting and other soil forming factors are weak. The soil properties most affected by differences in parent material in the survey area are bulk density, available water capacity, fertility and availability of nutrients, permeability to air and water, thermal properties, and soil strength.

Lacustrine sediment that is made up mainly of diatoms is the material in which Tulana, Algoma, and Teeters soils formed. These soils have very low bulk density and extremely high available water capacity. Material from these soils have very low strength if it is used for embankments, particularly dikes and embankments that impound water. Klamath soils, which formed in alluvium weathered largely from diatomite, have similar properties.

Mantles and flows of dacitic, pumiceous ash and cinders cover much of the northern part of the survey area. The Lapine, Shanahan, Maset, and Yawhee soils formed in an air-deposited mantle of ash and cinders, as much as 4 centimeters in diameter, which are highly vesicular and have few lithic crystals. Maklak soils formed in pumice flow in glacial valleys. They have cinders that range to 10 inches or more in diameter including pumice and red and black scoria, and have much lithic crystal ash. Steiger and Tutni soils formed in water-deposited material from pumice flow, and Sycan soils formed in alluvium from air-deposited pumice. All of these soils have very low bulk density, very high available water capacity, rapid or very rapid permeability, and very low thermal conductivity and heat capacity as compared to other mineral soils.

The eruptions of Mount Mazama that resulted in the formation of Crater Lake covered much of the northern part of the survey area with a mantle of cinders and ash (29). Radiometric age dating of carbonized wood fragments in many places indicate that the deposits were laid down about 6,450 plus or minus 200 years before the present time (28).

The first eruption blew finely divided pumice to great heights, and it was propelled by southeasterly winds as far as northern Nevada (28, 8). In the survey area, the Maset and Yawhee soils formed in this lobe of the air-deposited ash mantle. With growing intensity of the eruptions the wind direction shifted to the northeast and fine ash was carried into northeast Oregon, Washington, Idaho, Montana, British Columbia, and Alberta. The particles of pumice produced in these eruptions are much larger than other pumice particles and include cinders as much as about 4 centimeters within the survey area. The Lapine and Shanahan soils formed mainly in the lobe of air-deposited pumice that resulted from these eruptions.

The ash and cinders are finest at the top and bottom of the mantle and are coarsest in the middle, reflecting the growing intensity of the eruptions and their final tapering off. The areas dominated by ashy and cindery soils on the general soil map accurately locate the airdeposited pumice mantle where its thickness is more than about 1 foot. Thickness of this mantle ranges from a few inches to more than 10 feet in the survey area.

The final eruptions of Mount Mazama immediately prior to its collapse sent glowing avalanches of pumice over the sides of the vent into glacial valleys and river canyons. These pumice flows, or nulee ardente, went as far as 35 miles down the Rogue River canyon on the west of the mountain and as far as Chemult to the north. One flow went down the glacial valley in which Sun Creek now courses, as far south as Fort Klamath in the Wood River Valley. The Maklak soil is on this flow adjacent to the southern boundary of Crater Lake Park. The Kirk-Chock map unit is in alluvium derived from it. The Steiger and Tutni soils also are in water-redeposited material from these flows. An additional flow coursed around the northern side of Sun Mountain into the survey area.

The ash in the air-deposited pumice mantle is hypersthene augite-dacite pumice with accessory hornblende. About 10 to 15 percent of the ash is lithic crystals of plagioclase, hypersthene, and small amounts of augite and hornblende. About 85 percent of the pumice flow consists of cinders as much as 10 inches in diameter, or more, of dacite pumice including a considerable amount of black and red scoria in the upper few feet. The fraction smaller than 1 millimeter has about 25 to 65 percent crystals, with plagioclase feldspar predominating over heavier minerals (28).

Most of the soils in basins formed in lacustrine or alluvial and lacustrine sediment weathered mainly from diatomite, tuff, and basalt. Montmorillonite is the dominant clay mineral produced by weathering in these soils (see table 16). Soils on lake terraces in the basins commonly are underlain by diatomite, or diatomite stratified with lacustrine sandstone, that mostly extends to a depth of more than 100 feet. Harriman and Dodes soils formed in material weathered partly from these deposits. Calimus soils formed in loamy lacustrine sediment that was deposited in terraces and terrace strands near the edge of basins up to elevations of about 4,700 feet. Calimus soils occur in many places on steep north-facing slopes in the southern basins but are virtually absent on steep south-facing slopes. Increased precipitation effectiveness resulting in closer growing vegetation on north-facing slopes has apparently protected the Calimus soil mantle from being removed by erosion. Only small areas of the moderately deep Capona soil mostly remain on the steeper south-facing slopes.

Some soils formed partly in sediment that washed off of lake terraces and partly in alluvium from outside the basins; such sediment in this survey is termed alluvial and lacustrine. The Henley, Laki, and Hosley soils are examples of these soils. Soils that formed in lacustrine and alluvial and lacustrine sediment in the survey area have somewhat lower bulk density and somewhat higher available water capacity compared to soils of similar texture and other mineral origin. They are low in sulfur, and this nutrient must be provided for successful legume culture.

Colluvium weathered mainly from andesite and basalt and composed mostly of rock fragments mantles steeper escarpments in many parts of the survey area. Dehlinger soils formed in colluvium in the drier, warmer parts and Woodcock and Oatman soils mostly formed in colluvium in the cold, moist parts. One Woodcock soil also formed in glacial outwash along the southern side of Upper Klamath Lake. The upper part of Woodcock soils has considerable ash and comparatively low bulk density. Halloysite is the dominant clay mineral formed by weathering, and some amorphous clay also is likely produced in the Woodcock soils (see table 16). Soils that formed in this colluvium have low available water capacity because of the large amount of rock fragments. They provide good sources of gravel in many places.

Fibrous organic material covers the floor of much of Upper Klamath Lake, and large areas and bays around the Lake have been diked and drained for irrigated cropland. The Lather soil formed in this material and has very low bulk density, very high available water capacity, critical plant nutrient deficiencies including copper, and very low thermal conductivity and heat capacity. It also is subject to continuing subsidence and, if it becomes dry, to the hazards of burning and wind erosion.

The material in which soils formed on lava tablelands may be of very complex origin. It seems likely that these stable land surfaces have served as tables on which volcanic ash, dust, and other material have accumulated. The basaltic lava that underlies the Merlin soil in many places appears fresh and unweathered. It does not appear to have produced the clay in the subsoil. A flow breccia that consists of subrounded to subangular cobbles and stones in a pale brown cemented matrix covers much of the tablelands. It seems probable that the weathering of this tufflike matrix in addition to whatever ash and dust may have fallen on the tableland have produced the high amount of clay in the subsoil of the Merlin and Ponina soils. Surface stones and cobbles on these extremely stony soils also could have originated from the weathering of this breccia, and frost heaving could then have pushed them to the surface. The subsoil of the Merlin soil and of the Ponina soil has few or no rock fragments. Excessive stoniness limits these soils for crops and for many other uses.

Alluvium is a minor parent material in the survey area because of its limited area extent. The origin and composition of the alluvium vary markedly from one basin to another. In the Wood River Valley alluvium is composed almost entirely of pumiceous ash and cinders. The Kirk and Chock soils formed in this material. Alluvium is of complex origin in the Sprague River Valley where Klamath, Ontko, and Dilman soils occur. The Klamath soil formed in silty alluvium weathered mainly from diatomite and is on aggrading flood plains of the Sprague River. Ontko and Dilman soils formed in stratified alluvium that includes thick layers of pumiceous ash; they are on slightly higher flood plains than Klamath soils. In the warmer basins, alluvium is in narrow banks along the Lost River and a few tributary streams and along the Klamath River. The Lakeview and Pit soils formed in this material. Soils that formed in alluvium mostly have low strength, high available water capacity, and low bulk density. Other properties vary considerably depending on the nature and origin of the alluvium.

Where the eruptions laid down mantles of ash and cinders, extensive areas of soils became part of the parent material. Buried soils make up the lower parts of the Shanahan, Maset, and Yawhee soils, and occur at a depth below 40 inches in the Lapine and other soils. These buried soils mostly resemble some soils that occur in the survey area which are shown on the soil map. The buried soil of the Yawhee soil appears almost identical to the Woodcock soil except it is somewhat lighter in the A1b horizon. The buried soils in the Shanahan soils are very similar to Lobert soils on slopes of less than 12 percent, and they resemble Woodcock soils where slopes exceed 12 percent. The buried soil in most of the Maset soils appears to have been a Royst soil and, in many places where the soil is shallower, the buried soil appears to have been a Nuss soil. In large areas of Royst soils and the Nuss-Royst map unit that are adjacent to Maset soils, the buried soil horizon is consistently lighter than their present day analogs. It is probable that much of the organic matter has been removed from this horizon by oxidation or leaching, or both.

Relief

Relief and landforms have been dominant factors in soil formation and in determining the distribution of soils in the survey area. Relief controls surface drainage and natural erosion and can affect the amount of water that enters and passes through the soil. Relief controls erosion, which limits the thickness of material in which soils form and thickens the material deposited downslope.

Soils on very steep concave slopes are mostly very deep, and soils on less steep and convex slopes dominantly are shallow or moderately deep. Many nearly level to sloping soils near the base of escarpments are scoured by accumulated runoff and are underlain by bedrock at a shallow depth. Relief also determines the location of lakes, streams, marshes, soils that have a water table, soils that have alkali, and soils that are subject to flooding.

Most of the survey area is in the northernmost part of the Basin and Range Physiographic Province. The western and part of the northern edges are in the Cascade Range Province. The rest of the area on the north is bordered by the High Lava Plains of central Oregon.

Basins, locally called valleys, are enclosed on two or more sides by fault block mountains, and together with scattered rock benches and lava tablelands make up most of the Basin and Range part of the survey area. These basins and most of the mountains are oriented generally toward the northwest. The basins were sites of once deep lakes that covered about one-third of the area during the Pleistocene epoch. The faulting that produced the basins and separate mountain ranges occurred at the end of the Pliocene and the beginning of the Pleistocene Epochs. Upper Klamath and Agency Lakes are small remnants of these great lakes that once filled the basins to depths of many hundreds of feet.

Lake terraces were formed when the lakes filled to a different water depth and then receded. The last filling probably deposited the loamy sediment in which the Calimus soils formed before overtopping the edge of the basin near Keno, cutting an outlet, and draining the interconnected lake system. The maximum observed height of these deposits is about 700 feet above the basin floor. Older fillings of the lake to a lesser depth appear to have produced the terraces on which the Harriman, Modoc, and Dodes soils formed in the Klamath Valley. Nearly all of these soils are at an elevation ranging from 4,100 to 4,400 feet. A drainage system, consisting mostly of the Lost and Klamath Rivers and small tributary streams, formed in the bottom of the basins after the lakes receded.

The fault block mountains that separate the basins in the survey area commonly are cuestas that consist of a very steep upthrust side and a somewhat less steep downthrust side. Some of the mountains which have sides of nearly equal steepness are called hogbacks. A vertical series of lavas of Pliocene age and interbedded lacustrine rocks are exposed in the escarpments. These lavas are overlain in places by lacustrine deposits, tuff, and by other fragmented volcanic rocks. The sedimentary and pyroclastic rocks are capped by a series of basaltic and andesitic flows of late Pliocene and Quaternary age. The Dehlinger, Lorella, Woodcock, some of the Royst soils, and the Rock outcrop-Dehlinger complex are on the escarpments of these mountains.

Scattered over the survey area between the northern end of Yonna Valley and the Sprague River Valley are a series of tuff rings or maars which are the centers of small volcanoes that mostly erupted in water (15). The Rock outcrop-Nuss complex is on these landforms.

Many rock benches and lava tablelands of gently sloping topography are between escarpments north and east of Bly Mountain (15). The Nuss-Royst association is on the rock benches, and the Merlin-Yancy association and the Ponina-Rock outcrop complex mainly are on the tablelands.

Many volcanic cones are scattered over the northern part of the survey area and along the western side of Upper Klamath Lake in the Cascade Mountains (29). The largest of these cones is Pelican Butte whose eastern flank protrudes slightly into the area. Oatman and Woodcock soils are on this eastern part of Pelican Butte. Maset soils are on Ferguson Mountain, a volcanic cone northeast of Beatty; and Yawhee soils are on the twin peaks of Saddle Mountain southeast of the town of Sprague River. Fuego soils are on a few small plug domes, for example, Council and Bug Buttes, and Medicine Mountain.

Time

The span of time in which parent material has been in place and influenced by other soil forming factors can determine many soil properties. Of special importance is the amount of clay that is produced by weathering in the upper part of the soil and that has been washed down by percolating water to accumulate in the subsoil. This process of clay accumulation in the subsoil is called illuviation. Generally, a period of a few to many thousands of years is needed to produce a significant amount of illuviation. However, darkening of the surface layer by the accumulation of organic matter can occur in a few hundreds of years. Development of soil structure in the subsoil also can form in a relatively short time compared to the accumulation of clay. The ages of soils sometimes are stated as youthful, mature, and old depending on the degrees to which the described characteristics and processes have been impressed in the soil.

Relief, particularly slope and its relative position, can determine the time that soil material remains in place to be acted upon by soil forming processes. The Klamath soil is on aggrading flood plains in the Sprague River Valley. Sediment here is being deposited at the surface more rapidly than clay can accumulate in the subsoil, and no significant amount of illuviation has occurred.

The parent material of the pumice soils, deposited about 6,500 years ago, also has not been in place long enough for a subsoil of illuvial clay to form. Only a darkening of the upper few inches by organic matter and a slight weathering of the pumice mostly has occurred.

The Calimus soils formed in lacustrine sediment which was deposited at elevations ranging from 4,100 to about

4,700 feet in the Klamath Valley. This sediment must have been deposited at least 11,000 years ago, the time of the last filling of the lakes in the Pleistocene Epoch. The subsoil of the Calimus soil has only slightly more clay than the surface layer and does not represent significant illuviation, however, which indicates that more than 11,000 years are needed in the semiarid basins in the survey area to form an illuvial subsoil. On the other hand, the Dodes, Modoc, and Harriman soils on lake terraces lower than many Calimus soils have a strongly expressed illuvial subsoil and probably formed in a much older sediment that was deposited in a period of lake history when the water level in the lakes was much lower.

Lava tablelands, for example, Knott Tableland, are stable surfaces on which soils tend to remain for a long period of time. The Merlin soils on these tablelands have a strongly expressed illuvial subsoil that is more than 60 percent clay. The Ponina and Yancy soils on tablelands have a strongly expressed illuvial clay subsoil and a thick indurated duripan. Some Yancy soils are on old high terraces along the southern side of the Sprague River Valley. These terraces probably equal the tablelands in age.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single mapping unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile
or to a limiting layer is expressed as

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil. .

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of mill iequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured (light textured) soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are-

Loose.-Noncoherent when dry or moist; does not hold together in a mass.

Friable.-When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.-When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.-When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other *material.*

Hard.-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.-When dry, breaks into powder or individual grains under very slight pressure.

Cemented.-Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.-Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.-Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well *drained.*-Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.-Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.-Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.-Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.-Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess alkali. Excess exchangeable sodium. The resulting poor physical properties restrict the growth of plants.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts. Excess water soluble salts. Excessive salts restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May.

Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material from 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3. inches (7.5 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Gypsum. Hydrous calcium sulphate.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.-An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.-The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.-A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.-The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.-The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hummocky. Refers to a landscape of hillocks, separated by low sags, having sharply rounded tops and steep sides. Hummocky relief resembles rolling or undulating relief, but the tops of ridges are narrower and the sides are shorter and less even.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are-

Border.-Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.-Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.-Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.-Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.-Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.-Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.-Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.-Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Leaching. The removal of soluble material from soil or other material by percolating water.

Light textured soil. Sand and loamy sand.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance-*few, common, and many;* size-*fine, medium, and coarse*; and contrast-*faint, distinct*, and *prominent. The* size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20 percent.

Munsell notation. A designation of color by degrees of the three single variables-hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by water that originated mainly from the melting of glacial ice. Glacial outwash is commonly in valleys on landforms known as valley trains, outwash terraces, eskers, kame terraces, kames, outwash fans, or deltas.

Outwash plain. A land form of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil. A pan impedes the movement of water and the growth of roots. The word "pan" is commonly combined with other words that more explicitly indicate the nature of the layer; for example, *hardpan, fragipan, claypan, plowpan, and traffic pan.*

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water of subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Poorly graded. Refers to soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land supporting some forest trees.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized *are-excellent, good,* fair, and poor. The classification is based on the percentage of original, or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as-

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulates over disintegrating rock.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. Locally, a small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Slow refill. The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: very *coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); very *fine sand* (0.10 to 0.05 millimeter); silt (0.005 to 0.002 millimeter); and clay (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are *platy* (laminated), pris*matic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to-shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, sift foam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or " very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Trace elements. The chemical elements in soils, in only extremely small amounts, essential to plant growth. Examples are zinc, cobalt, manganese, copper, and iron.

Tuff. A compacted deposit 50 percent or more volcanic ash and dust.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but the limited geographic soil area does not justify creation of a new series.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Water-supplying capacity. Water stored in the soil at the beginning of plant growth in the spring, plus rainfall not in excess of evapotranspiration during the growing season, less runoff.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water. *Water table, apparent*. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.